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DOCUMENTS

OF THE

SENATE

OF THE

STATE OF NEW YORK,

ONE HUNDRED AND FIFTEENTH SESSION.

1892.

VOLUME X — NOS. 64 to 67, INCLUSIVE.

ALBANY:
JAMES B. LYON, STATE PRINTER.
1892.

University of the State of New York

NEW YORK STATE MUSEUM

1892 10

FORTY-FIFTH ANNUAL REPORT

OF THE

REGENTS

FOR THE YEAR 1891

TRANSMITTED TO THE LEGISLATURE FEBRUARY 3, 1892

ALBANY
JAMES B. LYON, STATE PRINTER
1892

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REGENTS

OF THE

UNIVERSITY OF THE STATE OF NEW YORK

(February 1892)

[The Laws of 1889, ch. 529, made the State Library and State Museum departments of the University.]

George William Curtis, LL.D., *Chancellor*
Anson J. Upson, D.D., LL.D., *Vice-Chancellor*
Roswell P. Flower, Governor
William F. Sheehan, Lieutenant-Governor
Frank Rice, Secretary of State
Andrew S. Draper, LL.D., Sup't of Pub. Instruction
Ex-officio

In order of election by the legislature

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Francis Kernan, LL.D., 1870	Utica
Martin I. Townsend, LL.D., 1873	Troy
Anson J. Upson, D.D., LL.D., 1874	Glens Falls
William L. Bostwick, 1876	Ithaca
Chauncey M. Depew, LL.D., 1877	New York
Charles E. Fitch, M. A. 1877	Rochester
Orris H. Warren, D.D., 1877	Syracuse
Leslie W. Russell, LL.D., 1878	New York
Whitelaw Reid, LL.D., 1878	New York
William H. Watson, M.D., 1881	Utica
Henry E. Turner, 1881	Lowville
St Clair McKelway, LL.D., 1883	Brooklyn
Hamilton Harris, LL.D., 1885	Albany
Daniel Beach, LL.D., 1885	Watkins
Willard A. Cobb, M.A. 1886	Lockport
Carroll E. Smith, 1888	Syracuse
Pliny T. Sexton, 1890	Palmyra
T. Guilford Smith, M.A., C.E. 1890	Buffalo

Melvil Dewey, M.A. *Secretary*, Albany
Albert B. Watkins, Ph. D., *Assistant Secretary*, Albany

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ANDREW S. DRAPER, Sup't of Public Instruction, *Chairman*
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State Museum Staff

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CHARLES H. PECK, M. A. (Union) – – – *State Botanist*
J. A. LINTNER, Ph. D. – – – – *State Entomologist*
JOHN C. SMOCK, M. A. (Rutgers), Ph. D. (Lafayette), *Economic Geologist*
JOHN M. CLARKE, M. A. (Amherst) – *Assistant Paleontologist*
WILLIAM B. MARSHALL, M. S. (Lafayette) – *Assistant Zoologist*
PHILIP AST – – – – – – – – *Lithographer*
MARTIN SHEEHY – – – – – – – *Messenger*
JACOB VAN DELOO – – – – – – – *Clerk*

STATE OF NEW YORK.

No. 64.

IN SENATE,

FEBRUARY 3, 1892

FORTY-FIFTH ANNUAL REPORT

OF THE

NEW YORK STATE MUSEUM

To the Legislature of the State of New York

I have the honor to submit herewith, pursuant to law, as the 45th annual report of the regents of the University on the New York State Museum the report of the director of the museum with appendices, of the botanist and the entomologist.

GEORGE WILLIAM CURTIS
Chancellor

NEW YORK STATE MUSEUM.

REPORT OF THE DIRECTOR, 1891.

REPORT OF DIRECTOR.

To the Honorable the Board of Regents of the University of the State of New York:

Gentlemen. — I have the honor to transmit herewith the reports of Mr. F. J. H. Merrill, Assistant Director, and of Mr. Wm. B. Marshall, Assistant in Zoology, showing the nature of the work accomplished and the condition of the collections in the several departments of the Museum on State street. The crowded condition of the rooms and the pressing need for more space for the arrangement and exhibition of the collections, especially in the Zoological department is well stated in Mr. Marshall's report. The need of space is equally great in the Geological department while there are no adequate or proper working rooms in the building for either of the departments.

The duties of the Director in which he is engaged separate him from the building known as the State Museum or Geological Hall, and he is compelled to confine himself almost exclusively to the collection and preparation of material, and the publication of the work on the Paleontology of the State, which is the incompleted work of the original Geological and Natural History Survey of the State of New York. Unfortunately the Museum building affords no adequate working rooms or space for the arrangement of the very large collections which have been accumulated for use in this work during its progress.

By the law of 1883, these collections were placed in the custody of the Trustees of the State Museum; the same law provided that the State Hall, whenever it should be vacated by the State officers, should be given into the custody of the Trustees of the Museum to be fitted up for the exhibition of collections and for working rooms for the State Museum of Natural History. A portion of the upper story of the building became vacated in 1885 and was fitted up with drawers for the arrangement of the Paleontological collections and for working rooms. In 1886 the collections which had been made by the writer since 1856 and arranged in two buildings of his own, were transferred to the State Hall, and, so far as space permitted, were arranged in the drawers just mentioned. Besides the collections filling these drawers there are a large number of boxes (at least 400) still remaining, from which the specimens have never been unpacked, and are therefore quite inaccessible for study or for any intelligent use.

All this property whether arranged in drawers or stored in boxes belongs to the State Museum, and forms a part of its collections, though disposed in a building at considerable distance from the Museum proper. Owing to this condition we labor under many disadvantages, for it is not possible, while occupying temporary quarters to fit up cases, arrange and dispose of collections as if we were in permanent occupancy. The Museum and the State suffers great loss from this condition, for we are constantly working under the disadvantage which necessitates a *temporary arrangement* of all our material, and we are often compelled to make room for new material by displacing collections already in use, and packing them in boxes, thus constantly increasing the amount of inaccessible material.

In 1883 it was anticipated that the proposed new quarters could be occupied in two or three years at the utmost; more than seven years have already elapsed and we have no assurance, nor even any prospect of alleviation from the present unfortunate condition.

The report of the State Geologist herewith communicated will show the nature and extent of the work done in these departments, and the condition of the printing on volume VIII, part I and the progress made in the second part of the same work, which has extended far beyond what could possibly have been foreseen in the outset. The need of more space for the increasing collections in these departments has already been stated, and we need at this time the space of fully 500 additional drawers which can only be had by packing and storing collections already arranged. The present occupancy of drawers is greater than needed for the work in progress, but by packing away the specimens in boxes they are made inaccessible for the purpose of selecting specimens for school collections which we are yearly called upon to furnish. Chiefly for this reason we need the great number of drawers now in use.

I have already on former occasions recommended that the collections be carefully examined and those needed for the Museum separated from those which are strictly duplicates. These duplicates should be made up in sets for school and college collections, be recorded and catalogued; after which the sets can be readily graded and given to the schools, academies, etc., according to their needs. To do this work, however, would require an assistant with knowledge of fossils who could work under my direction. The present Assistant Paleontologist has quite sufficient work of much more importance on his hands, and cannot undertake the work of distributing these collections.

The Albany Institute, at its regular meeting on the 20th day of October, 1891, passed a resolution, donating its collections of minerals, fossils, shells, stuffed skins of birds and mammals, alcoholic specimens and historic relics to the State Museum. These collections had been previously packed and delivered at the State Hall and State Museum and acknowledgment of the same had been made in the report.

In conclusion I wish to call your especial attention to the need of more room in every one of the departments of the Museum and trust that some means may be found of mitigating our present condition.

Very respectfully,
Your obedient servant,
JAMES HALL,
Director.

Report on the Work of the State Museum.

By **Frederick J. H. Merrill**, Assistant Director.

The scientific work immediately under the charge of the Assistant Director is that in Mineralogy and Economic Geology; the last title including the investigation of the mineral resources of the State.

The time of the Assistant Director has been chiefly occupied in the general business of the office and in directing the work enumerated below. Preliminary visits have been made during the year to the iron districts of Port Henry and Crown Point, and to the garnet deposits of Essex and Warren counties, and a geological survey of Albany county has been begun with a view to the construction of a geological map of the county.

In Geology, a collection of 443 specimens of Westchester county rocks has been made by Mr. E. M. Blake of Columbia College, and during the work of collecting, a large area of that county has been mapped geologically.

In Economic Geology, Mr. H. Ries of New York City has made a careful study of the brick clays and the brick industry of the Hudson River Valley in their economic aspects and has prepared a report illustrated by numerous photographs and specimens.*

Mr. I. P. Bishop of the State Normal School, Buffalo, N. Y., has prepared a report upon the progress of the salt industry of Central New York, illustrated by photographs.†

Mr. Wm. B. Marshall has communicated a short paper on marls.

The papers of Mr. Bishop and Mr. Marshall are appended to this report.

A paper on the Geological History of the Hudson River Valley, which will form a part of the report on clays, has been published in advance, in the American Journal of Science for June.

During the remainder of the calendar year, if opportunity permits, it is proposed to continue the study of the salt region.

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† Incorporated in Bulletin No. 11.

* Appended to the Report of the State Geologist for the year 1890.

Report on the Zoological Department.

By **William B. Marshall**, Assistant Zoologist.

For the year beginning October 1, 1890, and closing September 30, 1891, the Zoological Department of the New York State Museum reports as follows:

Early in the year, at the suggestion of the Assistant Director, I began work upon the Gould and Smithsonian collections of shells with a view to rearranging them in more systematic order, re-identifying the specimens and revising the nomenclature, and replacing the old labels, which were in ordinary handwriting and on very thin paper, with new printed labels of better design.

About 500 species have been re-identified, of which some have been arranged in the exhibition cases in systematic order. Labels have been printed giving the generic, subgeneric and specific names; locality; geographical distribution of the species and the name of the collection to which the specimens belong. The addition of the geographical distribution to each label is something that, so far as I am aware, has not been attempted to any great extent in any museum. A knowledge of the places where a species may be found adds immensely to the interest one takes in looking at natural objects. The fact that our labels will give this information will make the collection both entertaining and instructive.

The collection is being arranged in the two series of table-cases, occupying the middle portion of the floor. It is our design to incorporate in this collection, specimens of all species of mollusks in our possession, unless they are required for completing the collection illustrating the fauna of the State of New York. Formerly the collection of shells which occupied this area was composed exclusively of shells purchased from the late Dr. Augustus A. Gould. It was very incomplete. Many species which were lacking in this collection were at hand in the collection presented by the Smithsonian Institution and in species derived from other sources. These latter were stored away in drawers, and were practically inaccessible to the public, and their existence was comparatively unknown to students. By combining all the shells in our possession, except the Mazatlan collection, which has restrictions attached to it, we hope to form a collection which will reflect credit upon the institution and be far more instructive to the public. As the work of rearrangement progresses from year to year, it is proposed to publish a catalogue ot the collection.

With this report is furnished a catalogue of the family Muricidæ as defined in Tryon's Manual of Conchology. (See Appendix.)

The series illustrative of the molluscan fauna of the State of New York is in progress of rearrangement and enlargement. The same general method has been applied to this as to the general collection. The Long Island shells presented by Temple Prime and the collection which has heretofore been known as the State Series are to form the nucleus of the State collection. So far as possible, specimens exhibited in this series are from localities within our own State. In some cases, however, specimens from localities far distant have been incorporated to avoid gaps. To make room for this collection the Beecher collection of Unionidæ has been very much contracted, the duplicates having been placed in drawers.

Recently the ground glass in the ends of the entire suite of upright floor-cases, containing birds and small animals, has been removed and replaced by a good quality of double-thick clear glass. The ground glass thus obtained has been used to replace the painted glass in the windows east side of building and in the southeast and southwest corner. The paint on the panes in the end sashes of wall-cases on the north side of the room has been removed. These changes have resulted in a great improvement in the illumination of the Zoological floor, and in making the general appearance of the room more attractive. The clear glass in the ends of the case enable one to obtain views of portions of specimens which cannot be seen from the front. The walls and ceilings of the northwest wall-case and the large west wall-case containing the moose, bisons, etc., have been washed and kalsomined.

In June I spent two days in the town of New Baltimore, Greene county collecting fossil specimens of recent mollusca, from a deposit of fresh-water marl on the Van Slyke farm. The marl yielded only sixteen species of (fresh-water) shells to my search, although it is probable that originally there were many more species, which, in the course of time, have been destroyed, A notable absence of large bivalves was noticed, the largest bivalve observed being *Sphærium rhomboideum.*

Towards the close of July, I took the African birds and some other foreign birds in our collection to Philadelphia for identification at the Academy of Natural Sciences. In all about sixty-five specimens were named. I wish to express my thanks to Mr. Witmer Stone, ornithologist to the Academy, for the very valuable aid which he rendered me in accomplishing the task.

The specimens of young Unionidæ, which were loaned to Mr. Robert T. Jackson, of Boston, for the study of young stages of Pelecypods, about the early part of 1890, have been returned in good condition. Mr. Jackson kindly presented to the State Museum an interesting series of young oysters and Anomiæ which are illustrative of his paper on the "Phylogeny of the Pelecypoda."

An opportunity was given to Mr. Wm. Dutcher, Treasurer of the Ornithologists' Union to examine the male and female Labrador ducks contained in our collection.

Dr. C. E. Beecher of Yale University has been afforded an opportunity to study the collection of recent Brachiopods. Several of the specimens have furnished valuable data, which will be published in the American Journal of Science in the course of a paper on the phylogeny of the Brachiopoda.

The additions to the collection for the year include some interesting and valuable specimens. A skeleton of an African ostrich has been purchased and placed on exhibition for the purpose of showing the structural differences between carinate and ratite birds. A pair of Heath Hens, or the eastern variety of Pinnated Grouse *Tympanuchus cupido* (Linn.) (male and female), have been obtained. This bird, which was formely found on Long Island, and in New Jersey, Pennsylvania and other States further south, has become extinct in all these places and is confined exclusively to the island of Martha's Vineyard, Mass. Even in this place the bird is not plentiful and is in great danger of becoming altogether extinct. Although the male was taken on the 22d of December, his crop was reported to contain grasshoppers and leaves. Dr. Lintner, State Entomologist, states that such an occurrence is not at all strange, as living grasshoppers are sometimes found upon the snow in the midst of winter.

Other birds of more than passing interest which have been added to the collection are: a Black Gyrfalcon (*Falco rusticolus obsoletus*, [Gm.]), shot in Monroe Co., N. Y.; a pair (male and female) of Evening Grosbeaks (*Coccothraustes vespertinus* [Coop.]). shot in Wayland, Steuben Co., N. Y.; and a Turkey Buzzard (*Cathartes aura* [Linn.]), shot in Clarendon, Orleans Co., N. Y.

The Black Gyrfalcon is said to be rare everywhere. The specimen under consideration is remarkable because of its very dark color. The Evening Grosbeak, while not usually considered a member of the avian fauna of New York, occasionally comes into the state from the westward. The Turkey Buzzard is not plentiful in our state.

Dr. F. J. H. Merrill has presented fine specimens of shells from our own state and from the coast of Florida.

Mr. John M. Clarke, Assistant Palæontologist, has presented a small collection of shells gathered in Ontario county, N. Y. These shells are interesting and valuable as coming from a county of which the mollusks are almost entirely unrepresented in our collection. The collection also contains the specimens of *Gundlachia* from Sucker Brook, concerning which Mr. Clarke published a note in the American Journal of Science, March, 1882.

The skeleton of the elephant "Columbia," which was last year reported to be at Rochester undergoing maceration, has not yet been delivered to the museum. The work upon it is nearly completed and the specimen will be ready for shipment next month.

A list of the additions to this department is appended. Notes which are believed to be of interest are added to some of the entries in the list.

Charles W. Samson, who has been employed since December, 1890, in the capacity of page in Geological Hall, has made himself generally helpful to me when his time has not been otherwise occupied.

The need of more space for the exhibition of material belonging to the Zoological Department becomes more imperative every month. The floor allotted to Zoology is full — crowded. The arrival of a new addition of any considerable size causes a waste of time and energy in the shifting which is necessary to make room for its accommodation. An attempt to exhibit all the species of any one group of animals usually results in the retirement of other species or groups equally important. How urgent is the need of more space may be understood from the fact that it would be practically impossible to find space enough to exhibit one more specimen as large as a horse.

Equally vexatious are the insufficient facilities for storage of specimens, alcohol, glass-ware, trays, labels, instruments, shelving and many other things which are indispensible in an institution of this kind. The need of more space and greater convenience is pressing in the matter of work rooms and offices also. The curator of the Zoological collection has an office six feet by ten feet on the first floor of Geological Hall in a corner of the mineral room. In order to consult the Zoological collection it is necessary to ascend three and one-half flights of stairs. This takes time which should be more profitably utilized, and results in separating the curator from books which should be close at hand but which are necessarily kept in the office on the first floor.

Respectfully submitted,

WM. B. MARSHALL,
Assistant Zoologist.

ALBANY, N. Y., *September* 30, 1891.

ADDITIONS TO THE MUSEUM COLLECTIONS.

The Albany Institute has donated to the State Museum its extensive collection of minerals, fossils, shells and alcoholic specimens. During the next year this material, most of which is now stored in boxes, will be unpacked and catalogued so far as possible.

ZOOLOGY.

BY PURCHASE.

Centrocercus urophasianus (Bonap.). Sage Grouse. Male and female; Colorado.

Bonasa umbellus togata (Linn.). Canadian Ruffed Grouse. Male and female, Quebec, Canada, March 26, 1888.

Tympanuchus cupido (Linn.) Heath Hen, or Eastern Pinnated Grouse. Male taken on Martha's Vineyard, Mass., Dec. 22, 1890. Length 16 in.; Expanse 28¾ in.; Wing 12½ in.; Crop contained leaves and grasshoppers. Female, from same place, Dec. 24, or 25, 1890.

Falco rusticolus obsoletus (Gmel.). Black Gyrfalcon. Female, shot near Lake Ontario in Monroe Co., N. Y., in October, 1890. The label contains the following field notes; — Length 22½ in. Tail 9½ in. Wing 15½ in. Spread 51 in. Cere and feet grey (not so bright a grey as in the Osprey).

Cathartes aura (Linn.). Turkey Buzzard. Adult shot in the town of Clarendon, Orleans Co., N. Y., July 18th, 1891, by A. E. Snyder.

Struthio camelus (Linn.). African Ostrich. Mounted skeleton.

BY DONATION.

Mr. Z. A. D. Strevell, Altamont, Albany Co., N. Y.

Urinator imber (Gunn.), Northern Loon. Female shot at Warner's Lake, Albany Co., N. Y., November 1890.

Mr. Frank A. Ward, Rochester N. Y.

Coccothraustes vespertinus (Coop.), Evening Grosbeak. Male and female, shot at Wayland, Steuben Co., N. Y., in February, 1890.

BY COLLECTION.

Wm. B. Marshall.

Chelydra serpentina (Linn.), Snapping Turtle. Two specimens taken from mud at the bottom of a small stagnant pond in the town of New Baltimore, Greene Co., N. Y.

Chelopus insculptus (Le Conte), Wood Tortoise. Three specimens taken from high grass in a meadow near a rivulet, in the town of New Baltimore, Greene Co., N. Y.

Cistudo carolina (Linn.), Box Tortoise. A male, taken in a rye-field on a dry, sunny hill-side in the town of New Baltimore, Greene Co., N. Y.

Morone Americana (Gmel.), White Perch. Eight specimens. Hudson River, Albany, N. Y.

Clupea pseudoharengus (Wilson), Alewife. Two specimens. Hudson River, Albany, N. Y.

Catostomus teres (Mitch.), Common Sucker. Two specimens. Hudson River, Albany, N. Y.

BY PURCHASE.

Lamna cornubica (Gm.) Porbeagle or Mackerel Shark. Skull of a specimen captured off the coast of Hayti.

BY DONATION.

Mr. H. A. Pilsbry, Philadelphia, Pa.:

Lacuna sp? Terra del Fuego, 1 specimen.
Mounted odontophore of the above, 1 specimen.
Helix nemoralis, Linn., Lexington, Va., 11 specimens.
Ampullaria flagellata, Say., Vera Cruz, Mex., 4 specimens.
Tryonia protea, Gould, Indio, Cal., 100+ specimens.
Lucina Pennsylvania, Linn., Martinique, 3 specimens.

F. J. H. Merrill, Albany, N. Y.:

Murex pomum, Gm., S. of Tampa, Florida, 3 specimens.
Murex brevifrons, Lam., S. of Tampa, Florida, 2 specimens.
Urosalpinx cinereus, Say, New Rochelle, N. Y., 2 specimen.
Eupleura caudata, Say, Long Island., 1 specimen.
Cantharus tincta, Conr., S. of Tampa, Florida, 3 specimens.
Fulgur pyrum, Dillw., 1 specimen.
Fasciolaria gigantea, Kien (Opercula) Key West, Fla., 2 specimens.
Fasciolaria tulipa, Linn., var. distans, Lam., S. of Tampa, Florida, 5 specimens.
Marginella guttata, Dillw., Key West, Fla., 6 specimens.
Marginella interrupta-lineata, Muhlf., West Indies, 41 specimens.

Marginella carnea, Storer, Key West, Fla., 5 specimens.
Oliva litterata, Lam., S. of Tampa, Florida, 8 specimens.
Columbella fulgurans, Lam., 18 specimens.
Columbella lunata, Say, Sandy Hook, N. J., 5 specimens.
Conus Pealii, Green, S. of Tampa, Florida, 2 specimens.
Conus proteus, Hwass., S. of Tampa, Florida, 2 specimens.
Cancellaria reticulata, Linn., S. of Tampa, Florida, 4 specimens.
Strombus pugilis, Linn., var. alatus, Gm., S. of Tampa, Florida, 1 specimen.
Strombus bituberculatus, Lam., West Indies, 2 specimens.
Aporrhais pes-pelecani, Linn., 3 specimens.
Cypræa obvelata, Lam., 4 specimens.
Cassis sulcosa, Brug., S. of Tampa, Florida, 2 specimens.
Natica canrena, Linn., S. of Tampa, Florida, 2 specimens.
Sigaretus perspectivus, Say. Key West, Fla., 2 specimens.
Crepidula aculeata, Gm., Key West, Fla., 1 specimen.
Cerithium atratum, Born., S. of Tampa, Florida, 3 specimens.
Littorina irrorata, Say., Key West, Fla., 3 specimens.
Littorina littorea,* Linn., New Rochelle, N. Y., 7 specimens.
Littorina scabra, Linn., var. nebulosa, Lam., S. of Tampa, Florida, 3 specimens.
Neritina reclivata, Say., Tampa, Florida, 31 specimens.
Astralium longispina, Lam., Key West, Florida, 1 specimen.
Hyalina cellaria, Müll., Leroy, N. Y., 1 specimen.
Hyalina arborea, Say., Deckertown, N. J., 12 specimens.
Helicodiscus lineatus, Say., McAfee, N. J., 1 specimen.
Helix alternata, Say., Deckertown, N. J., 1 specimen.
Helix labyrinthica, Say., McAfee, N. J., 2 specimens.
Helix labyrinthica, Say., Deckertown, N. J., 1 specimen.
Helix cereolus, Muhl., Key West, Fla., 23 specimens.
Helix Carpenteriana, Bland., Key West, Fla., 50 specimens.
Helix hirsuta, Say , Deckertown, N. J., 1 specimen.
Helix albolabris, Say., Leroy, N. Y., 2 specimens.
Helix Roemeri, Pfr., Fort Worth, Texas, 4 specimens.
Helix thyroides, Say., Leroy, N. Y., 1 specimen.
Helix Berlandieriana, Moricand., Fort Worth, Texas, 2 specimens.
Helix Berlandieriana, Moricand., Austin, Texas. (Post pliocene.) 18 specimens.

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* L littorea reached New Rochelle between 1884 and 1890. The specimens listed were collected by Dr. Merrill in April, 1890. For a history of the southward spread of the species on the Atlantic coast of North America see a paper by S. Smith in the Proc. Nat. Sci. Ass'n, Staten Island, June 14, 1888.

Bulimulus dealbatus, Say., Fort Worth, Texas, 50 specimens.

Bulimulus dealbatus, Say., Austin, Texas. (Post pliocene.) 6 specimens.

Orthalicus undatus, Brug., Cape Sable, Florida, 2 specimens.

Cionella subcylindrica, Linn., Deckertown, N. J., 1 specimen.

Pupa incana, Binn., Key West, Florida, 1 specimen.

Pupa fallax, Say., McAfee, N. J., 1 specimen.

Pupa armifera, Say., Deckertown, N. J.. 9 specimens.

Pupa contracta, Say., Deckertown, N. J., 1 specimen.

Succinea luteola, Gould, Key West, Fla., 15 specimens.

Melampus bidentatus, Say., South Amboy, N. J., 15 specimens.

Limnæa columella, Say., Blind Brook, Rye, N. Y., 2 specimens.

Limnæa humilis, Say., Hudson River, West Point, N. Y., 10 specimens.

Physa ancillaria, Say., Blind Brook, Rye, N. Y., 7 specimens.

Physa ancillaria, Say., Hudson River, West Point, N. Y., 3 specimens.

Planorbis trivolvis, Say., Hudson River, West Point, N. Y., 28 specimens.

Planorbis trivolvis, Say., Mill Brook, Fordham, N. Y., 2 specimens.

Planorbis bicarinatus, Say., Blind Brook, Rye, N. Y., 3 specimens.

Planorbis bicarinatus, Say., Hutchinson's Cr., Westchester Co., N. Y., 7 specimens.

Planorbis bicarinatus, Say., Mill Brook, Fordham, N. Y., 1 specimen.

Pomus depressus, Say., Southwest Florida, 2 specimens.

Melantho decisa., Say., Hutchinson's Cr., Westchester Co., N. Y., 1 specimen.

Gillia altilis, Lea., Hudson River, West Point, N. Y., 1 specimen.

Pomatiopsis lustrica, Say., Hudson River, West Point, N. Y., 1 specimen.

Helicina orbiculata, Say., Fort Worth, Texas, 30 specimens.

Unio luteolus, Lam., Grand Island, Niagara River, 1 specimen.

Unio complanatus, Sol., Upper Longwood, N. J., 1 specimen.

Unio complanatus, Sol., Lake Pleasant, Herkimer Co., N. Y., 1 specimen.

Unio complanatus, Sol., Ramapo River, Oakland, N. Y., 1 specimen.

Margaritana marginata, Say., Westchester Co., N. Y., 1 specimen.

Anodonta fluviatilis, Dillw., Macopin Lake, N. J., 1 specimen.

Ensis Americanus, Gould, South Amboy, N. J., 4 specimens.

Tellina radiata, Linn., S. of Tampa, Florida, 4 specimens.

Tellina radiata, Linn., Key West, Fla., 2 specimens.

Tellina interrupta, Wood., S. of Tampa, Florida, 1 specimen.

Macoma Balthica, Linn., South Amboy, N. J., 7 specimens.

Callista gigantea, Gm., Tampa, Fla., 1 specimen.

Callista maculata, Linn., West Indies, 2 specimens.
Dosinia discus, Rve., Tampa, Fla., 1 specimen.
Cardium muricatum, Linn., S. of Tampa, Florida, 1 specimen.
Cardium Isocardia, Lam., West Indies, 2 specimens.
Lævicardium serratum, Lam., West Indies, 2 specimens.
Lævicardium Mortoni, Conr., Long Island, 5 specimens.
Lucina Pennsylvanica, Linn., Tampa, Fla., 2 specimens.
Lucina Pennsylvanica, Linn., Key West, Fla., 5 specimens.
Lucina Pennsylvanica, Linn., West Indies, 3 specimens.
Loripes edentula, Linn.
  var. chrysostoma, Mörch., S. of Tampa, Florida, 2 specimens.
Astarte castanea, Say., East Hampton, L. I., 2 specimens.
Mytilus edulis, Linn., West Hampton, L. I., 1 specimen.

Mr. John M. Clarke. Albany N. Y.

Land and aquatic shells from Ontario county, New York, as follows:

Hyalina arborea, Say., 14 specimens.
Hyalina intertexta, Binn., 8 specimens.
Helicodiscus lineatus, Say., 1 specimen.
Macrocyclis concava, Say., 2 specimens.
Helix alternata, Say., 9 specimens.
Helix perspectiva, Say., 12 specimens.
Helix striatella, Anthony, 3 specimens.
Helix hirsuta, Say., 7 specimens.
Helix monodon, Rackett, 1 specimen.
Helix palliata, Say., 5 specimens.
Helix tridentata, Say., 19 specimens.
Helix albolabris, Say., 15 specimens.
Helix albolabris, Say. (young), 9 specimens.
Helix albolabris, Say. (with tooth), 3 specimens.
Helix thyroides, Say., 8 specimens.
Helix Sayi, Binn., 3 specimens.
Helix pulchella, Müll., 11 specimens.
Helix Sp? (young), 7 specimens.
Cionella subcylindrica, Linn., 7 specimens.
Pupa corticaria, Say., 7 specimens.
Vertigo simplex, Gould, 1 specimen.
Succinea obliqua, Say., 8 specimens.
Limnæa stagnalis, Linn. Broken. Interesting because the epidermis has peeled off in spiral bands, 7 specimens.

Limnæa desidiosa, Say., 13 specimens.

Limnæa sp? 24 specimens.

Physa ancillaria, Say., 6 specimens.

Physa heterostropha, Say., 6 specimens.

Planorbis campanulatus, Say., 24 specimens.

Planorbis trivolvis, Say., 23 specimens.

Planorbis bicarinatus, Say., 24 specimens.

Planorbis exacutus, Say., 4 specimens.

Planorbis parvus, Say. A greatly deformed specimen, manuscript label containing the name "Valvata deformata." One specimen.

Ancylus rivularis, Say., 15 specimens.

Gundlachia (Meekiana, Stimpson).

(See note by Mr. Clarke in American Journal of Science, March, 1882.) Three specimens.

Valvata tricarinata, Say., 5 specimens.

Valvata tricarinata, Say. var. simplex.

Body-whorl round instead of quadrate; epidermis green instead of straw-color; whorls of spire carinate as in typical specimens. Two specimens.

Valvata arenifera, Lea. (Larval insect case, *Helicopsyche glabra*, resembling the shell of Valvata), 1 specimen.

Melantho decisa, Say., 30 specimens.

Amnicola Sayana, Anthony, 7 specimens.

Amnicola porata, Say., 3 specimens.

Sphærium simile, Say., 5 specimens.

Sphærium stamineum, Conr., 7 specimens.

Helix palliata, Say., Sauquoit, Oneida Co., N. Y., 1 specimen.

Mr. Robert T. Jackson, Boston, Mass:

A large series of young oysters and Anomiæ, from Buzzard's Bay, Mass., naturally attached to glass slides and other objects; illustrative in part of a paper by the donor on the "Phylogeny of the Pelecypoda" (Memoirs of the Boston Society of Natural History, Vol. IV. July, 1890.)

Dr. Charles E. Beecher, New Haven, Conn:

Cæcum pulchellum, Stimp., Naushon I., Mass., 15 specimens.

Helix Cooperi, Binn. Deadwood, N. Dakota, 1 specimen.

Melampus bidentatus, Say. New Haven, Conn., 2 vials.

William B. Marshall, Albany, N. Y.:

The following specimens collected at Cape May, N. J., August, 1891,

Limulus Polyphemus, Latreille, Horseshoe Crab.

Found on sandy beach, Delaware Bay.

Gelasimus pugilator, Latreille, Fiddler Crab.

Found burrowing in the mud at the mouth and along the banks of a creek, and on salt-marshes.

Cancer irroratus, Say. Sand Crab.

Carcinus granulatus, Say. Green Crab.

Above two species found together in large burrows of their own making, and in sheltered depressions, in mud banks on the ocean front exposed between tides.

Platyonichus ocellatus, Latr., Lady Crab.

Found at the water's edge on the ocean front.

Callinectes hastata, Ord., Edible Crab.

A large male from an inlet.

A female with incrustations of two species of Bryozoa and with very young oysters crepidulas and barnacles adhering to back and legs, from a gully on the ocean beach.

Pelia mutica, Say. Spider Crab.

From sandy beaches and mud beds on the ocean front between tides

Hippa talpoida, Say. Beach Flea.

Found at water's edge on ocean front.

Eupagurus pollicaris, Stimp. Larger Hermit Crab.

Found walking unprotected on the beach.

Eupagurus longicarpus, Stimp. Smaller Hermit Crab.

From exposed beach between tides, in pools about piles, and in depressions in mud beds, inhabiting shells of various small gasteropods.

Melampus bidentatus, Say.

From salt marshes.

Nassa obsoleta, Say.

Large specimens from the surface of mud in a small inlet which becomes dry as the tide recedes. Small specimens from the surface of mud in the mouth of a small creek. During low tide the mud is exposed. As the tide rises, salt water enters the mouth of the creek and covers the mud, but is made brackish by the fresh water of the creek.

Fulgur carica, Gm.

Sycotypus canaliculatus. Linn.

Egg-capsules containing embryonic shells from the shore of Delaware Bay.

Columbella lunata, Say.

Found clinging to a tubularian (Parypha crocea, Ag.) growing in a hollow in the top of a short pile on the ocean front, between tides.

Crepidula unguiformis, Lam.

Adhering to dead shells rolling on the beach, between tides.

Crepidula fornicata, Linn.

From surface of dead shells, and living crabs on the ocean-front; and from the surface of king-crabs on the shore of Delaware Bay.

Pholas truncata, Say.

Very young specimens, measuring less than a centimeter in length. Associated with the next species.

Petricola pholadiformis, Lam.

Found burrowing in mud-beds on the ocean front, exposed between tides.

Also pieces of hard clay with holes bored by Pholas and Petricola.

Modiola plicatula, Lam.

Found imbedded in mud on a marsh at the side of a small inlet which becomes dry as the tide recedes.

Mytilus edulis. Linn. Edible mussel.

Found attached to mudbeds and piles on the ocean front, exposed between tides.

Mytilus edulis, var. pellucidus, Penn.

Associated with the preceding but not so plentiful.

Masses of broken shells, pebbles and clay, bound together with byssal threads of Mytilus edulis.

Hydractinia echinata.

Coating shells inhabited by Eupagurus longicarpus.

Parypha crocea, Ag. (A Tubularian.)

From a hollow in the top of a short pile, on the ocean-front, exposed between tides.

GEOLOGY.

By Donation.

G. E. Van Guysling, Albany, N. Y.

Coquina, Fort Marion, St. Augustine, Fla.

Coquina, City Gates, St. Augustine, Fla.

Z. W. Vanderolf.

Granite, Quarry of M. Mallen, Mount Adam, Orange Co. N. Y.

Wagner Palace Car Co., Buffalo, N. Y.
Set of borings from gas well 3045 feet deep.

By Collection.

H. Ries, New York City.
Specimens of brick and brick clays from the Hudson River Valley.

E. M. Blake, Columbia College, N. Y.
Westchester County Rocks. 443 specimens.

MINERALOGY.

By Exchange.

National Museum, Washington, D. C.

Cut Specimens.

Amazon Stone, Amelia Courthouse, Va.
Amethyst, Brazil.
Agate, five specimens.

By Donation.

S. L. Penfield, Yale University Museum.
Heulandite, Cape Blomidon, N. S.
Apophyllite, Cape Blomidon, N. S.
Lithiophyllite, Branchville, Conn.
Dickinsonite, Branchville, Conn.
Albite and Muscovite, Branchville, Conn.
Siliceous oölite, State College, Pa. two specimens.

William W. Jefferis, Esq., Philadelphia, Pa.
Fibrolite, Norwich, Conn.
Biotite, Easton, Pa.

J. M. Griffith, Fulton Co., N. Y.
Gypsum, crystallized, Oneonta, N. Y.

David Cowan.
Magnetite, Rossway, Digby Co., N. S.
Red Hematite, Porbrook, South Mountain, Kings Co., N. S.

Rev. Richmond Shreve, Albany.
Steatite, Kings Co., N. S.
Gypsum, Blomidon, Kings Co., N. S.
Amethyst, Blomidon, Kings Co., N. S., four specimens.
Chalcedony, Blomidon, Kings Co., N. S., two specimens.
Crystallized quartz, Blomidon, Kings Co., N. S., four specimens.
Stibnite, Blomidon, Kings Co., N. S., one specimen.

CATALOGUE OF MURICIDÆ,

IN THE COLLECTION OF THE

NEW YORK STATE MUSEUM

(EXCLUSIVE OF THE MAZATLAN COLLECTION)

IDENTIFIED AND ARRANGED IN ACCORDANCE WITH

TRYON'S MANUAL OF CONCHOLOGY.

FAMILY MURICIDÆ.

	Locality.	Source.	Specimens.
Subfamily Muricinæ.			
Genus Murex, Linn.			
Murex scolopax, Dillw		Gould Coll	1
Murex tribulus, Linn	"Sicily"	Gould Coll	4
Murex tribulus, Linn		Gould Coll	2
Murex tribulus, Linn		U. S. Expl. Expd.	1
Murex tenuispina, Lam		Gould Coll	5
Murex ternispina, Lam	Philippine Islands	Gould Coll	2
Murex ternispina, Lam		Gould Coll	11
Murex ternispina, Lam		Smithsonian Inst.	1
Murex ternispina, Lam		U. S. Expl. Expd.	1
Murex turnispina, Lam		H. Cuming	1
Murex plicatus, Sowb	San Juan, Lower California	Gould Coll	2
Murex recurvirostris, Brod		Gould Coll.	5
Murex recurvirostris, Brod	Mazatlan, Mex	Gould Coll	2
Murex recurvirostris, Brod	Jamaica	Gould Coll	3
Murex recurvirostris, Brod			2
Murex chrysostoma, Gray	St. Thomas, W. I.	Gould Coll	2
Murex haustellum, Linn		Gould Coll	5
Murex haustellum, Linn		U. S. Expl. Expd.	2
Murex haustellum, Linn	China	Wesley Newcomb	1

Subgenus Pteronotus, Swains.			
Murex triqueter, Born		Gould Coll	3
Murex triqueter, Born		U. S. Expl. Expd	1
Murex triqueter, Born		H. Cuming	1
Murex lingua, Dillw	Senegal, W. Africa	Gould Coll	1
Murex Adamsi, Kobelt		Gould Coll	1
Murex pinnatus, Wood		Gould Coll	2
Murex pinnatus, Wood	China		2
Murex uncinarius, Lam		Gould Coll	1
Subgenus Chicoreus, Montf.			
Murex palma-rosæ, Lam		Gould Coll	2
Murex palma-rosæ, Lam		H. Cuming	1
Murex maurus, Brod		Gould Coll	6
Murex microphyllus, Lam		Gould Coll	3
Murex microphyllus, Lam		H. Cuming	1
Murex torrefactus, Sowb		Gould Coll	3
Murex torrefactus, Sowb		U. S. Expl. Expd	2
Murex adustus, Lam	Mergui, Burmah	Gould Coll	2
Murex adustus, Lam	"Bahamas"	Gould Coll	5
Murex adustus, Lam		U. S. Expl. Expd	1
Murex adustus, Lam	Bombay		1
Murex adustus, Lam		Gould	3
Murex axicornis, Lam		Gould Coll	2
Murex axicornis, Lam., var. aculeatus, Lam		Gould Coll	1
Murex anguliferus, Lam		Gould Coll	1
Murex anguliferus, Lam	Red Sea	Gould Coll	6
Murex Senegalensis, Gm		Gould Coll	2
Murex Senegalensis, Gm	"New Zealand"	Gould Coll	1

FAMILY MURICIDÆ — (*Continued*).

	Locality.	Source.	Specimens.
Subgenus Chicoreus, Montf.— (*Continued*).			
Murex Senegalensis, Gm	Rio Janeiro	U. S. Expl. Expd	1
Murex Senegalensis, Gm			1
Murex capucinus, Lam		Gould Coll	6
Murex capucinus, Lam		Smithsonian Inst	1
Murex ramosus, Linn		Gould Coll	8
Murex ramosus, Linn		J. C. Smock	2
Murex brevifrons, Lam		Gould Coll	16
Murex brevifrons, Lam	S. of Tampa, Fla	F. J. H. Merrill	2
Murex brevifrons, Lam	St. Domingo	Gould Coll	1
Murex elongatus, Lam	China	H. Cuming	1
Murex pomum, Gm	St. Thomas, W. I	Gould Coll	4
Murex pomum, Gm	S. of Tampa, Fla	F. J. H. Merrill	3
Murex pomum, Gm		Gould Coll	4
Subgenus Rhinocantha, H. & A. Ad.			
Murex brandaris, Linn	Sicily	Gould Coll	5
Murex brandaris, Linn		Smithsonian Inst	1
Murex brandaris, Linn	Mediterranean Sea	Smithsonian Inst	1
Murex brandaris, Linn	Mediterranean Sea		5
Murex cornutus, Linn		Gould Coll	1
Murex cornutus, Linn			1

Subgenus Homalocantha, Mörch.			
Murex scorpio, Linn		Gould Coll	4
Subgenus Phyllonotus, Swains.			
Murex brassica, Lam	Mazatlan	Gould Coll	2
Murex regius, Wood		Gould Coll	3
Murex regius, Wood			1
Murex regius, Wood	Panama		2
Murex regius, Wood			1
Murex bicolor, Val	Mazatlan	Gould Coll	1
Murex saxatilis, Lam		Gould Coll	1
Murex saxatilis, Lam			1
Murex endivia, Lam		Gould Coll	2
Murex endivia, Lam		U. S. Expl. Expd	1
Murex multicrispatus, Dkr		Gould Coll	1
Murex nitidus, Brod	Mazatlan	Gould Coll	2
Murex radix, Gm		Gould Coll	2
Murex radix, Gm	Panama		3
Murex radix, Gm			1
Murex princeps, Brod		Gould Coll	1
Murex spinicostatus, Val		Gould Coll	2
Murex trunculus, Linn	Mediterranean Sea	Gould Coll	5
Murex trunculus, Linn		Gould Coll	1
Murex trunculus, Linn			1
Murex trunculus, Linn			1
Murex hexagonus, Lam.		Gould Coll	2
Murex dubius, Sowb	Acapulco	Smithsonian Inst	1
Murex pauxillus, A. Ad	Mazatlan	Gould Coll	2

FAMILY MURICIDÆ — (*Continued*).

	Locality.	Source.	Specimens.
Subgenus Cerostoma, Conrad.			
Murex foliatus, Martyn	Neeah Bay, Wash	Gould Coll	1
Murex foliatus, Martyn		Gould Coll	2
Murex foliatus, Martyn	California	Smithsonian Inst	1
Murex foliatus, Martyn	Vancouver	Smithsonian Inst	2
Murex Burnetti, Ads. & Rve	Hakodadi Bay, Japan	Gould Coll	2
Murex Nuttalli, Conr		Gould Coll	4
Murex Nuttalli, Conr	California	Smithsonian Inst	1
Murex festivus, Hinds		Gould Coll	1
Subgenus Ocinebra, Leach.			
Murex erinaceus, Linn	Great Britain	Gould Coll	1
Murex erinaceus, Linn	Great Britain		1
Murex erinaceus, Linn		Gould Coll	1
Murex erinaceus, Linn., var. torusus, Lam		Gould Coll	1
Murex Edwardsi, Payr	Mediterranean Sea	Gould Coll	3
Murex aciculatus, Lam	Great Britain	Gould Coll	1
Murex aciculatus, Lam	Mediterranean Sea	Smithsonian Inst	1
Murex aciculatus, Lam	Great Britain		2
Murex tetragonus, Brod., var. breviculus, Sowb		Gould Coll	5
Murex incisus, Brod		Gould Coll	6
Murex crassilabrum, Gray		Gould Coll	5

Murex crassilabrum, Gray	Chile	Smithsonian Inst	2
Murex crassilabrum, Gray	Peru		2
Murex crassilabrum, Gray	Valparaiso, Chile	Albany Inst	12
Murex crassilabrum, Gray			1
Murex alveatus, Kien		Gould Coll	1
Murex luridus, Midd	Vancouver	Smithsonian Inst	5
Murex luridus, Midd., var. munda, Carp	Vancouver	Smithsonian Inst	5
Murex luridus, Midd., var. aspera, Baird	Vancouver	Smithsonian Inst	2
Murex interfossus, Cpr	Vancouver	Smithsonian Inst	2
Murex interfossus, Cpr	Vancouver	Smithsonian Inst	2
Subgenus Vitularia, Swains.			
Murex salebrosa, King		Gould Coll	4
Murex Sandwichensis, Pse		Smithsonian Inst	1
Genus Trophon, Montf.			
Trophon craticulatus, Fab., var. orpheus, Gld	Puget Sound	Smithsonian Inst	1
Trophon Barvicensis, Johnst	England	Smithsonian Inst	1
Trophon clathratus, Linn	England	Smithsonian Inst	1
Trophon clathratus, Linn., var. multicostatus, Esch	Vancouver	Smithsonian Inst	1
Trophon clathratus, Linn		Gould Coll	3
Trophon crispus, Gld	Orange Harbor, Chile	Smithsonian Inst	1
Trophon laciniatus, Martyn	Orange Harbor, Chile	Smithsonian Inst	1
Trophon Geversianus, Pall	Cape Horn	Gould Coll	2
Trophon Geversianus, Pall	Orange Harbor, Chile	Smithsonian Inst	2

FAMILY MURICIDÆ — (*Continued*).

	Locality.	Source.	Specimens.
Genus Trophen, Moutf.— (*Continued*).			
Trophon Geversianus, Pall	Cape Horn	Albany Inst	2
Trophon Geversianus, Pall., var. ambiguus	Orange Harbor, Chile	Smithsonian Inst	2
Trophon Geversianus, Pall., var. Philippianus, Dkr	Orange Harbor, Chile	Smithsonian Inst	1
Trophon fimbriatus, Hinds	Hong Kong, China	N. Pacific Expl. Expd.	1
Trophon xanthostoma, Brod	Chile	Gould Coll	3
Trophon xanthostoma, Brod	Chile	Smithsonian Inst	1
Genus Urosalpinx, Stimp.			
Urosalpinx cinereus, Say		Gould Coll	44
Urosalpinx cinereus, Say	New Rochelle, N. Y	F. J. H. Merrill	4
Urosalpinx cinereus, Say	Long Island	Temple Prime	5
Urosalpinx cinereus, Say	Greenport, L. I	Temple Prime	12
Urosalpinx cinereus, Say	Coast of the United States	State Coll	8
Genus Eupleura, H. & A. Ad.			
Eupleura caudata, Say	South Carolina	Gould Coll	6
Eupleura caudata, Say		Gould Coll	1
Eupleura caudata, Say	Long Island	Temple Prime	2
Eupleura caudata, Say	United States	State Coll	3
Eupleura nitida, Brod	Panama	Gould Coll	5

Subfamily Purpurinæ.			
Genus Purpura, Brug.			
Purpura patula, Linn	Mazatlan	Gould Coll.	10
Purpura patula, Linn		U. S. Expl. Expd	1
Purpura patula, Lam	West Indies		4
Purpura patula, Linn	St. Croix, West Indies		2
Purpura haustrum, Martyn	New Zealand	Smithsonian Inst	1
Purpura haustrum, Montf	New Zeland	Gould Coll	2
Purpura Persica, Linn		Gould Coll.	4
Purpura Persica, Linn		U. S. Expl. Evpd	1
Purpura Rudolphii, Ch.		Gould Coll.	2
Purpura chocolatum, Ducl. (young)		Gould Coll.	1
Purpura chocolatum, Ducl.		U. S. Expl. Expd	1
Purpura chocolatum, Ducl. (young)		U. S. Expl. Expd	1
Purpura chocolatum, Ducl	"Lower California."		1
"Purpura nux, Rve"	Cape of Good Hope	Smithsonian Inst	1
Subgenus Purpurella, Dall.			
Purpura columellaris, Lam.	Mazatlan	Gould Coll	4
Subgenus Tribulus, Klein.			
Purpura planospira, Lam		Gould Coll.	1
Purpura planospira, Lam	Cape St. Lucas	Smithsonian Inst	1
Purpura aperta, Blainv		Gould Coll	6

FAMILY MURICIDÆ — (*Continued*).

	Locality.	Source.	Specimens.
Subgenus Tribulus, Klein — (*Continued*).			
Purpura aperta, Blainv.	Sandwich Is.	Smithsonian Inst.	1
Purpura aperta, Blainv.		U. S. Expl. Expd	5
Subgenus Thalessa, H. & A. Ad.			
Purpura hippocastaneum, Lam.		Gould Coll.	12
Pupural hippocastaneum, Lam.	Tavoy, Burmah	Gould Coll.	7
Purpura hippocastaneum, Lam.		U. S. Expl. Expd	4
Purpura hippocastaneum, Lam., var. intermedia, Kien.	Sandwich Is.	Gould Coll	2
Purpura hippocastaneum, Lam., var. intermedia, Kien	Ceylon	Smithsonian Inst.	1
Purpura hippocastaneum, Lam., var. alveolata Rve.		Gould Coll	6
Purpura tumulosa, Rve.		Gould Coll.	4
Purpura pica, Blainv.		Gould Coll.	6
Purpura pica, Blainv.		U. S. Expl. Expd	2
Purpura pica, Blainv	Pacific Ocean		2
Purpura armigera, Ch.		Gould Coll	2
Purpura armigera, Ch.		U. S. Expl. Expd.	1
Purpura armigera, Ch.			3
Purpura armigera, Ch		Smithsonian Inst	1
Purpura triserialis, Blainv.	Mazatlan	Gould Coll	1
Purpura deltoidea, Lam.		Gould Coll	5
Purpura melones, Ducl.	Peru	Gould Coll	2
Purpura melones, Ducl.	Panama	Wesley Newcomb	1
Purpura mancinella, Linn		Gould Coll	6

Purpura mancinella, Linn		Smithsonian Inst	1
Purpura bimaculata, Jonas		Gould Coll	1
Purpura neritoidea, Linn	Cape Verde	Gould Coll	3
Purpura neritoidea, Linn	Cape Verde	Smithsonian Inst	1
Purpura bufo, Lam	Mergui, Burmah	Gould Coll	4
Subgenus Stramonita, Schum.			
Purpura luteostoma, Ch	Chusan I., E. coast of China	Gould Coll	2
Purpura luteostoma, Ch	Loo Choo Is	Smithsonian Inst	2
Purpura luteostoma, Ch		Gould	5
Purpura hæmastoma, Linn	San Juan, Lower Cal	Gould Coll	8
Purpura hæmastoma, Linn		Gould Coll	7
Purpura hæmastoma, Linn	Cape Verde	Smithsonian Inst	1
Purpura hæmastoma, Linn	Madeira	Smithsonian Inst	2
Purpura hæmastoma, Linn	Panama		1
Purpura hæmastoma, Linn	Brazil		1
Purpura hæmastoma, Linn	West Africa		1
Purpura hæmastoma, Linn	Gulf of Mexico	Gould Coll	9
Purpura hæmastoma, Linn	Mazatlan	Gould Coll	1
Purpura hæmastoma, Linn., var. bicostalis, Lam	La Paz, Lower Cal	Gould Coll	3
Purpura hæmastoma, Linn., var. bicostalis, Lam	Peru	Smithsonian Inst	2
Purpura hæmastoma, Linn., var. bicostalis, Lam	Pacific Ocean		1
Purpura hæmastoma, Linn., var. bicostalis, Lam		Gould Coll	1
Purpura hæmastoma, Linn., var. undata, Ch		Gould Coll	5
Purpura hæmastoma, Linn., var. Blainvillei, Desh	Coast of Cumana, Venezuela	Gould Coll	6
Purpura hæmastoma, Linn., var. Blainvillei, Desh	Peru	Smithsonian Inst	3
Subgenus Trochia, Swains.			
Purpura succincta, Martyn		Gould Coll	12
Purpura succincta, Martyn	Port Jackson	Smithsonian Inst	1

FAMILY MURICIDÆ — (*Continued*).

	Locality.	Source.	Specimens.
Subgenus Trochia, Swains — (*Continued*).			
Purpura succincta, Martyn	New Zealand	Smithsonian Inst	1
Purpura succincta, Martyn., var. squamosa, Lam		Smithsonian Inst	1
Subgenus Polytropa, Swains.			
Purpura scobina, Quoy	New Zealand	Smithsonian Inst	2
Purpura harpa, Conr.		Gould Coll	5
Purpura scobina, Quoy		Gould Coll	2
Purpura harpa, Conr.	Sandwich Is	Smithsonian Inst	1
Purpura harpa, Conr.	Sandwich Is		1
Purpura lapillus, Linn	Vancouver	Gould Coll	16
Purpura lapillus, Linn. (varieties)	California	Smithsonian Inst	21
Purpura lapillus, Linn	Montauk, L. I.	Temple Prime	2
Purpura lapillus, Linn	United States	State Coll	3
Purpura lapillus, Linn	Great Britain	Smithsonian Inst	5
Purpura lapillus, Linn., var. crispata, Ch	Vancouver	Gould Coll	11
Purpura lapillus, Linn., var. crispata, Ch	Niphon, Japan	Gould Coll	2
Purpura lapillus, Linn., var. crispata, Ch		Gould Coll	6
Purpura lapillus, Linn., var. emarginata, Desh	La Paz, Lower Cal	Gould Coll	8
Purpura lapillus, Linn., var. emarginata, Desh	California	Smithsonian Inst	1
Purpura lapillus, Linn., var. saxicola, Val	Puget Sound	Smithsonian Inst	2
Purpura lapillus, Linn., var. saxicola, Val		Smithsonian Inst	11
Purpura lapillus, Linn., var. saxicola, Val	California	Smithsonian Inst	3
Purpura lapillus, Linn., var. saxicola, Val	Niphon, Japan	Smithsonian Inst	1

Purpura ostrina, Gld. (=P. lapillus, Linn. var.)	Puget Sound	Gould Coll	Type 1
Purpura ostrina, Gld. (=P. lapillus, Linn. var.)	Killimack, Or	Gould Coll	Type 1
Purpura ostrina, Gld. (=P. lapillus, Linn. var.)	Vancouver to Cal	Gould Coll	Types 5
Purpura lapillus, Linn., var. canaliculata, Ducl	Vancouver	Smithsonian Inst	2
Subgenus Cronia, H. & A. Ad.			
Purpura buccinea, Desh		Gould Coll	1
Opercula of Purpura, Sp.?		U. S. Expl. Expd	2
Genus Iopas, H. & A. Ad.			
Iopas sertum, Brug		Gould Coll.	3
Iopas sertum, Brug		U. S. Expl. Expd	2
Iopas sertum, Brug	Pacific Ocean		1
Iopas sertum, Brug	Sandwich Islands		1
Genus Ricinula, Lam.			
Ricinula hystrix, Linn		Gould Coll	1
Ricinula hystrix, Linn., var. clathrata, Lam		Gould Coll	3
Ricinula hystrix, Linn., var. clathrata, Lam		Smithsonian Inst	1
Ricinula horrida, Linn. (young)		Gould Coll	9
Ricinula horrida, Lam.	California	Gould Coll	1
Ricinula horrida, Lam.		U. S. Expl. Expd	4
Ricinula horrida, Lam.	Sandwich Islands		1
Ricinula iodostoma, Less		Gould Coll	1

FAMILY MURICIDÆ—(*Continued*).

	Locality.	Source.	Specimens.
Genus Ricinula, Lam.—(*Continued*).			
Ricinula ricinus, Linn		Gould Coll	2
Ricinula ricinus, Linn	Sandwich Islands	Gould Coll	6
Ricinula ricinus, Linn		Smithsonian Inst	1
Ricinula ricinus, Linn		U. S. Expl. Expd	4
Ricinula ricinus, Linn			1
Ricinula ricinus, Linn., var. elegans, Brod		Gould Coll	1
Ricinula ricinus, Linn., var. elegans, Brod		Smithsonian Inst	1
Ricinula digitata, Lam		Gould Coll	9
Ricinula digitata, Lam		Smithsonian Inst	1
Subgenus Sistrum, Montf.			
Ricinula morus, Lam		Gould Coll	12
Ricinula morus, Lam		Smithsonian Inst	2
Ricinula tuberculata, Blainv	Gulf weed, Atlantic	Gould Coll	11
Ricinula tuberculata, Blainv		Smithsonian Inst	1
Ricinula Anaxeres, Ducl		Gould Coll	1
Ricinula Anaxeres, Ducl		Smithsonian Inst	1
Ricinula marginatra, Blainv		Smithsonian Inst	2
Ricinula marginatra, Blainv		Smithsonian Inst	1
Ricinula ochrostoma, Blainv		Gould Coll	3
Ricinula ochrostoma, Blainv		Smithsonian Inst	1
Ricinula dumosa, Conr		Gould Coll	11

Ricinula dumosa, Conr		Smithsonian Inst	1
Ricinula cancellata, Quoy		Gould Coll	3
Ricinula cancellata, Quoy	Sandwich Is	Smithsonian Inst	1
Ricinula cancellata, Quoy		Smithsonian Inst	1
Ricinula fiscellum, Ch		Smithsonian Inst	2
Ricinula undata, Ch		Gould Coll	16
Ricinula undata, Ch		Smithsonian Inst	5
Ricinula undata, Ch., var. albovaria, Küster		Gould Coll	4
Ricinula concatenata, Lam	"Mediterranean Sea"	Gould Coll	4
Ricinula concatenata, Lam		Smithsonian Inst	2
Ricinula concatenata			5
Ricinula ferruginea, Rve	St. Lucas, L. Cal.	Smithsonian Inst	2
Ricinula musiva, Kien		Gould Coll	3
Ricinula musiva, Kien		Smithsonian Inst	2
Genus Monoceros, Lam.			
Monoceros muricatum, Brod	San Juan, L. Cal	Gould Coll.	5
Monoceros lugubre, Sowb.		Gould Coll.	1
Monoceros lugubre, Sowb.	Margarita Bay, L. Cal.	Smithsonian Inst	1
Monoceros brevidentatum, Gray		Gould Coll.	1
Monoceros calcar, Martyn		Gould Coll.	6
Monoceros calcar, Martyn		U. S. Expl. Expd.	5
Monoceros calcar, Martyn, var crassilabrum, Lam.		Gould Coll.	5
Monoceros calcar, Martyn, var. crassilabrum, Lam.		U. S. Expl. Expd.	4
Monoceros calcar, Martyn, var. crassilabrum, Lam.	Peru		1
Monoceros calcar, Martyn, var. citrinum, Sowb		Gould Coll.	2
Monoceros engonatum, Conr		Gould Coll.	3
Monoceros engonatum, Conr	California	Smithsonian Inst	1
Monoceros lapilloides, Conr		Gould Coll.	5
Monoceros lapilloides, Conr	California	Smithsonian Inst	1

FAMILY MURICIDÆ — (*Concluded*).

	Locality.	Sources.	Specimens.
Genus Pseudoliva, Swains.			
Pseudoliva plumbea, Ch.		Gould Coll.	1
Pseudoliva sepimana, Rang	Eastern Africa	Gould Coll.	1
Genus Chorus, Gray.			
Chorus Belcheri, Hinds	California	Smithsonian Inst	1
Genus Concholepas, Lam.			
Concholepas Peruvianus, Lam		Gould Coll.	6
Concholepas Peruvianus, Lam		U. S. Expl. Expd	5
Concholepas Peruvianus, Lam			1
Genus Cuma, Humph.			
Cuma kiosquiformis, Ducl	Panama	Gould Coll	3
Cuma carinifera, Lam		Gould Coll	1
Cuma coronata, Lam	Senegal	Gould Coll	2
Cuma coronata, Lam		Gould Coll	3
Cuma gradata, Jonas	Singapore	Smithsonian Inst	1
Cuma rugosa, Born	Singapore	Smithsonian Inst	1
Cuma rugosa, Born	Burmah	Gould Coll	1
"Cuma muricina, Blainv."		Smithsonian Inst	1

Genus Rapana, Schum.			
Rapana bezoar, Linn		Gould Coll	3
Rapana bezoar, Linn	China		1
Rapana bulbosa, Sol		Gould Coll	1
Rapana bulbosa, Sol	Tavoy, Burmah	Gould Coll	2
Rapana bulbosa, Sol	Ceylon		1
Genus Rhizochilus, Steens.			
Subgenus Corralliophila, H. & A. Ad.			
Rhizochilus neritoideus, Lam.:		Gould Coll	10
Rhizochilus nux, Rve	C. St. Lucas	Smithsonian Inst	1
Rhizochilus costatus, Blainv	Mazatlan	Gould Coll	1
Genus Pseudomurex, Monterosato.			
Pseudomurex bracteatus, Brocc		Gould Coll	2
Genus Rapa, Klein.			
Rapa papyracea, Lam		Gould Coll	2

Report on a Deposit of Marl and Peat in the Town of New Baltimore.

By Wm. B. Marshall.

About four miles west of the Hudson river, in the town of New Baltimore, Greene county, is a deposit of marl and peat, which occupies a small valley at an elevation of about 340 feet above tide water, as determined by an aneroid barometer. The deposit, approaching seven acres in extent, is divided into two nearly equal parts, a northern and a southern, by a bed of rock which extends east and west across the valley about the middle. On the east and west sides the valley is inclosed by hills which are from 40 to 50 feet high. The drainage of the valley is from south to north, the south end being naturally open and admitting a small rivulet. Formerly there was no outlet for water through the bed of rock at the upper end of the southern section, but, some years ago, the owner, Mr. E. T. Van Slyke, by blasting out a passage, succeeded in draining the surface of this portion into the northern portion. The northern portion has no surface drainage as it is inclosed by low hills on the north as well as by the higher hills on the sides. The water in this half of the deposit drains into several openings in the underlying limestone and finds an outlet (probably into Hauncraus creek to the north) through subterranean passages. The entire surface of the deposit is now under cultivation. During the last summer the northern half was planted in rye and oats and the southern half was in meadow.

The peat and muck upon the surface of the marl in the southern portion is the result of an accumulation of successive growths of mosses and other plants during the period when the valley was a marsh and of leaves and twigs which have washed in from the neighboring hillsides. The peat and muck of the remainder of the deposit do not differ in character from the above, but a large portion of the material in the northern half has been washed in from the southern half. The small rivulet which now drains the southern lot is constantly carrying particles of marl and peat along with it and depositing them in the northern lot.

The marl is composed of the dead shells of fresh water mollusca and of carbonate of lime which has probably been carried down in solution from the Helderberg limestones and deposited in the valley. A short distance south of the locality under consideration and in the same valley is another deposit of the same character but somewhat larger. A smaller deposit lies about a mile to the northwest. There are other deposits, at various places in Greene county. They occur in hollows in which a considerable basin must be filled up before water can drain off.

The exact thickness of the deposits of muck and marl is not known. The muck is probably about four to five feet thick in some parts. An iron rod between ten and eleven feet in length was thrust perpendicularly into the bed by the writer. As only slight exertion was necessary to push the entire length of the rod in, it is probable that the deposit of marl is more than seven feet in thickness — how much more it is impossible at present to say.

Calcareous tufa is not found in considerable quantities. Small scales of it have formed on the rocks about one of the holes into which the water in the northern lot drains. These scales are one-quarter of an inch thick and are composed of several thin layers.

The marl contains only aquatic species of mollusca. The following is a list of the species that have been collected:

Valvata tricarinata, Say.
Valvata sincera, Say.
Planorbis campanulatus, Say.
Planorbis trivolvis, Say.
Planorbis bicarinatus, Say.
Planorbis exacutus, Say.
Planorbis parvus, Say.
Limnæa humilis, Say.
Carychium exiguum, Say.
Physa heterostropha, Say.
Physa ancillaria, Say.
Bulinus hypnorum, Linn.
Sphærium rhomboideum, Say.
Sphærium Sp.? (young of a rhomboid species).
Pisidium Virginicum, Say.
Pisidium ventricosum, Prime.

The shells which are most numerous belong to the genus *Valvata.* Two forms belonging to the genus are found to be about equally abundant. One of these is *Valvata tricarinata*, Say., and the other is either *Valvata sincera*, Say., or the variety *simplex* of *V. tricarinata.* In my opinion it is *V. sincera.* *V. tricarinata* is said to be a very variable species, varying from the typical tricarinate form through bicarinate, unicarinate and ecarinate forms. The latter has been designated as variety *simplex.* None of the specimens of *Valvata* found in the marl bed under consideration showed any of the intergradations between the tricarinate and ecarinate forms. All were either decidedly tricarnate or decidedly ecarinate. The absence of intermediate forms leads to the opinion that the ecarinate form is *Valvata sincera.*

A striking feature of the deposit is the absence of large bivalves. The plentiful supply of carbonate of lime and the luxuriant growth of mosses and other aquatic plants made the locality an extremely favorable one for freshwater mollusca. The presence of the remains of myriads of specimens attests the truth of the above, and yet no specimens of *Unio*, *Anodonta* or *Margaritana* were found. At the present day fifteen species of these animals are abundant in ponds and streams in the immediate neighborhood of the marl. Mather (Geol. N. Y. p. 11) says "Unios and Anodontæ are sometimes found in it (marl). Piles are sometimes seen on the edges of marl banks and on shores, that have been carried there by muskrats, to devour the testaceous animals." There are no Uniones in the State Museum's collection of shells from marl; the largest bivalve being *Sphærium simile*, from a deposit at Little Lakes, Herkimer county, N. Y.

In the muck many species of land shells were observed. A list of these is not given, as it is believed that a careful search would bring to light almost all the species known to inhabit the neighborhood. All that were found were either on the surface, or but a few inches underneath. Their presence beneath the surface is due to the fact that they have been turned under by the plough.

In the collection of the State Museum are nine teeth of a fossil horse which were found in 1889 by Mr. Bronk Van Slyke, imbedded in the peat in the southern lot. Dr. Charles E. Beecher, of Yale University, has identified them with *Equus fraternis*, Leidy. As the muck and marl are in a soft, plastic condition it is not improbable that other mammals have been imbedded and that their remains may be found. Before the swamp was drained the material was of a still more yielding nature.

So far as I am aware the only animals inhabiting the marl are earth-worms and one species of insect, of which there are immense numbers of the corneous pupæ, each measuring less than a millimetre in length. Their burrows traverse the marl in all directions. Dr. Lintner, State Entomologist, to whom specimens have been submitted, says that there is nothing to enable him to identify the species.

Roughly the amount of soluble carbonates contained in the marl is about 82 per cent. The insoluble material, of which about 40 per cent is organic, consists of sand and clay, leaf-mold and corneous insects.

Concerning the use of marl and muck for agricultural purposes there is not much to be said. Farmers with whom I have conversed seem to be of the opinion that these substances ought to make good fertililizers but apparently no extensive use has been made of them for this purpose. Such is certainly the case in Greene county. Experiments, conducted rather irregularly, have been made, and while it is generally conceded that the material did the land no harm, there is difference of opinion as to whether it did enough good to warrant the trouble taken to dig and spread it. The place is in close proximity to the limestone of the Helderbergs and the rocks underneath the soil are mostly limestone. It is possible that the soil in that neighborhood already contains a sufficient amount of carbonate of lime to meet all the needs of the crops.

There seems to be no doubt that lime in some form is beneficial to certain crops. The large amounts of land plaster, sulphate of lime, which are annually consumed bear testimony to this fact; and farmers, so far as I have been able to obtain their opinion, agree that lime has a beneficial effect upon soil which is to grow wheat.

On the subject of calcareous soils Dr. Beck (Mineralogy of New York, p. 90) remarks that "the most extensive are those which occur in the western part of the state; and no better evidence is required of the value of lime as a manure, than the proverbial fertility of this favored region." "Bergman found, in one of the most fertile soils of Sweden, thirty parts of carbonate of lime in the hundred."

In their reports to the legislature the geologists in charge of the various districts of the geological survey of the state urged the value of peat and muck and marl for increasing the fertility of soils.

On this subject Dr. Emmons (Agriculture of New York, p. 314) says:—"Where marl and peat exist, farmers ought never to complain of the scarcity of the means for improving the soil." "We have often spoken of the importance of using peat before it is dried or baked in the sun. When used in a dry state, or mixed in lumps in a soil, it will certainly disappoint the farmer; but when mixed in a compost with ashes, lime and other refuse matter it will always be found useful. When used in proper quantity on wheat lands, the berry will rarely if ever shrink; and could farmers in all parts of the state secure a supply of marl, peat, lime and ash compost, wheat of the finest quality might be raised equally well in all the districts."

On the same subject Mather (Geology of New York, first district, p. 11) says:—"In some parts of Orange and Dutchess counties, this marl is much used by the farmers, and with great advantage to their crops * * * but its value is not yet fully appreciated. It is desirable that agriculturists should make more extensive use of a manure so valuable as this, on soils that contain little lime."

According to analyses published by Emmons, the soils of the Highlands, the portion of the state east of the Hudson and the Adirondack region are very deficient in lime in any of its forms.

Mather thinks that shell marl might be used to replace a portion of the gypsum used for agricultural purposes. "Gypsum has been invaluable to the lands of the counties above the Highlands, and it is probable that the shell-marl deposits will be of as great a value to the farming interests."

The above quotations are given because I have been unable to find any later and more definite information bearing on the subject. Whether the suggestions of the geologists quoted would be sustained by a series of systematic experiments apparently remains undecided.

In reply to inquiries concerning the value of peat and marl as fertilizers, Dr. Collier, director of the State Experiment Station at Geneva, has kindly sent me the following letter:

New York Agricultural Experiment Station,
Geneva, N. Y., *Sept.* 16, 1891.

W. B. Marshall,
N. Y. State Museum, Albany, N. Y.:

My Dear Sir.— In reply to your favor of the 16th inst., I would say that, so far as I know, little has been done by the Experiment Stations in testing the qualities of fresh water marls and peats, although we have used carbonate of lime, of which fresh water marls are mainly composed, and peat, as top-dressing for some of our lands, with interesting results. There is no question, I think, as to the value of both these in changing the mechanical condition of soils to which they are applied and in that way having a great fertilizing value. The peat also furnishes to soils comparatively poor in organic matter these substances. I would refer you to page 168 of our Ninth Annual Report for certain results which seem to be due to the application of finely divided carbonate of lime. We are repeating this experiment this year.

Thanking you for calling my attention to the matter, I am,

Sincerely yours.

PETER COLLIER.

The report cited by Dr. Collier contains the following:

"In studies of sugar cane and sorghum soils the observation has been made that a good proportion of lime in the soils or in the fertilizers applied usually accompanies a good sugar crop. With the view of obtaining information on this point, one-half of each row of sorghum was top-dressed, as soon as planted, with crude precipitated carbonate of lime at the rate of 4000 pounds per acre, and from the arrangement of the rows, this made two limed strips running across the field with intervening and adjacent strips without lime. In regard to yield of cane and time of maturity, there was no noticeable difference between the strips, and the yield of seed it was not possible to determine. Analyses of juices from forty canes (twelve varieties) of like maturity, twenty from the limed and twenty from the unlimed strips, showed an average of ten per cent more sugar in the canes from the limed strips;

the average of cane sugar in the one lot being 11 31 per cent, and in the other 10.28 per cent. So far as a single experiment goes, this result is in accord with the idea that an application of some form of lime is of value to the sorghum crop on soils that contain little lime or in which the magnesia exceeds the lime. Every sample of soil from the station-farm that has been analyzed has contained less lime than magnesia, the average in all the top soils being .65 per cent of lime (CaO) and 1.21 per cent of magnesia (MgO)."

In view of the fact that there are immense deposits of various grades of marl and peat, extending in some cases, over thousands of acres and to be found in many parts of the state, the usefulness of these substances might be profitably investigated by some one familiar with the chemistry and practice of agriculture. Mather's suggestion that the marl might in a measure replace the use of gypsum for agricultural purposes is worthy of consideration. Such a substitution, if it were possible, would result in a saving to many farmers, particularly in the eastern and northeastern parts of the state.

Report on the Development of the Salt Industry of Central New York for the Year 1891.

By IRVING P. BISHOP.

The following information regarding the geological and business interests of the salt industry in Western New York has been collected during the months of July and August. West of Wyoming county I do not find that any well has been sunk in the salt since the date of my last report, in 1885. In the Warsaw field the development has gone on principally in the direction of enlargement of works and a greater production of salt, rather than in the development of new territory. Nearly every company has put down more wells so as to insure a larger supply of brine, but the wells are usually sunk in the immediate vicinity of those first put down, and so do not present any new geological features. The records have not usually been kept except that of the first well.

Some new wells sunk in the Oatka valley since 1885, furnish new geological information, as follows:

The new wells at Leroy show, according to the owners, twenty feet of rock salt, instead of shale containing a little salt, as recorded in my last report.

The Lehigh Salt Mining Company is sinking a shaft for the mining of salt on Lot 5, Range 5, Leroy, about two miles south of Leroy station, on the B. R. & P. R. R. (south side of track). Elevation of mouth of shaft above tide, 906 feet. The shaft is 12x24 feet, and was down about forty-five feet in the Marcellus shale at the time of my visit July thirtieth. A test well was sunk here to determine the quality of this salt. This reached salt at 765 feet, and was sunk to the depth of 900 feet.

The next well of interest is that at Pavilion. Finished July 6, 1891. Record furnished by M. E. Calkins.

	Feet.
Soil	51
Shale, Hamilton	374
Corniferous limestone	150
Lower Helderberg limestone	374
Shale	50
Salt bed	64
Shale	12
	1,075

The works for the manufacture of salt are now in process of erection, and will probably be ready for use before January first. A second well is also being sunk to supplement the first. The plant is owned and will be managed by Humphrey & Calkins. They will make common, fine, dairy and table salt as the market may require, and will use both pan and grainer processes. A manufactory has also been started at Pearl Creek station. This has two wells, and an apparent capacity of 400 to 600 barrels per day. The works are on the east side of the tracks of the B. R. & P. R. R., just north of the station.

Record of a well at Pearl Creek obtained from Otis & Barton, owners.

	Feet.
Soil	20
Hamilton shales, about	500
Corniferous limestone	90–100
Lower Helderberg (?) about	600
Salt and shale	20
Salt	55

Another company has just started, the Oatka Dairy Salt Company of Warsaw, N. Y. This company proposes to erect works with a capacity of about 600 barrels per day on the Horatio Graves property adjoining the Guinlock works near the B. R. and

P. station. It is sinking a well for fresh water which is down now about 250 feet, and if the supply is adequate, will sink from one to three salt wells. It will use both grainer and pan processes, and expects to be ready for work about February, 1892.

At Rock Glen extensive works have been erected since my last report. A record of the first well is given in my former report. The others including the first have the following depths for salt:

	Struck salt.	Completed well.
1	2,015	2,119
2	2,018	2,033
3	2,008	2,113
4		2,068
		2,126
		2,120
		2,145

Works have also been erected at Perry, N. Y., and are in operation.

In the Genesee valley no new localities have been developed. The new shaft of the Greigsville Mining Company is the only new feature.

This company is sinking a shaft for mining salt on the Gray farm on the west side of the D. L. and W. tracks about three-quarters of a mile north of Greigsville station and within half a mile of the Retsof. The shaft is on the site of the old "Well No. 4 Gray Farm" on lot 9, town of York. It is eleven by twenty-two feet and was down about 300 feet at the time of my visit, July 27, 1891. Shaft was started October 15, 1890.

I have also been able to get a complete record of the Retsof salt shaft, which record was incomplete at the date of my last report.

Complete Record of the Retsof Salt Shaft, Greigsville, N. Y.

Record of 784 feet from Wm. S. Potter. Superintendent of Mine. The rest from Mr. S. Gray. (For the first part see my report on salt, State Geologist's report of 1885, p. 29):

	Feet.
Shale	133
Limestone	8
Shale	232

	Feet.
Limestone	4
Shale	23
Limestone	2
Black shale with some oil	1
Corniferous limestone	142
Cement	13
Dark sandstone	4
Black and white cement	7
Sandstone	14
Gypsum	4
Cement	26
Gypsum	47
Magnesium limestone and sandstone	63
Cement	14
Blue Magnesian limestone	25
Cement	10
Blue Magnesian limestone	12
Cement	17
Lime, cement and sand	31
Cement	10
Lime and cement	15
Cement	6
Blue (Shale ?)	18
Red (Shale ?)	10
Blue (Shale ?)	44
Red (Shale ?)	5
Blue (Shale ?)	13
Limestone	12
Salt and shale	33
First bed salt	20
Limestone and shale	26
Second salt bed	4
Rock	2
Salt	58

The shaft is located on lot 17. The works have a capacity of 6,000 tons per day. Are mining about 400 tons as an average. The salt as it comes from the mine is broken and screened like coal and sold as "Coarse lump"—pieces weighing from twenty to 100 pounds, and coarse salt of about the grades of Syracuse "Diamond" C. & F., or about like Turk's Island.

Record of well on the Reed Farm, near the new shaft, Livonia, N. Y., furnished by Mr. D. D. Luther:

Clay, gravel and sand	56
Shale	464
Sand rock	10
Slate (Shale?)	302
Corniferous limestone	133
Hydraulic lime	45
Limerock	313½
Shale and salt	11½
Pure salt	35
Salt and shale	8
Pure salt	15
Soft shale	114

The first rock, according to Mr. Luther, is very near the top of the Genesee shale.

East of the Genesee valley three important wells have been sunk; at Ithaca, at Ludlowville on Cayuga lake, and at Morrisville, Madison Co.

The well at Ludlowville, on the Auburn Division Lehigh Valley R. R., about ten miles north of Ithaca, N. Y., constitutes the Cayuga Lake Salt Company.

Buildings are now in process of erection and it is expected will be ready for the manufacture of salt by December 1, 1891. I have not yet obtained a report of this well.

The remarkable well at Ithaca, N. Y., has been fully described by Prof. Charles S. Prosser in an admirable paper in the American Geologist of October, 1890, which see.

For the well at Morrisville I am also indebted to Prof. Prosser. His record is given herewith.

Depth.	Thickness.	
		Hamilton.
340′		Marcellus, first sample.
371′		Corniferous horizon of Oriskany sandstone.
441′ (?)		
	79′	
578′		Gas. Lower Helderberg limestone.
	2′	
650′		
	5′	
755′		
	32′	Hydraulic limestone.
975′		Light gray shale.
1018′		5′ of dark red shale.
	87′	
1110′		Green and blue marls.
1179′		
	36′	Limestone.
1215′		
1259′		10′–12′ of rock salt.
	141′	Red and green variegated marls.
1400′		
	60′	Red marl
1460′		
	105′	Green and blue marls.
1565′		
	225′	Red shale.
1790′		
1805′		Blue shale and limestone — Niagara ?
1849′		25′ blue shale.
1874′		
1889′		Blue shale and limestone.

Well at Dansville, N. Y., owned by the Dansville Oil, Gas and Mining Company, located on the Hyland farm, 735 feet above tide. Completed November 24, 1891.

	Feet.
Gravel, etc	30
Hard gritty slate	90
Dark sand, like Bradford	15
Light slate	65
Cased at 206 feet.	
Soft slate and shale	400
Small amount of salt water.	

	Feet.
Slate and shale	200
Small vein of gas at 775 feet.	
Dark slate, like roofing slate	100
Light blue slate, some gas	100
Dark blue slate, some gas	100
Slate and shale	620
Hard dark limestone	80
Hard granite (?)	60
Very hard lime rock	240
Solid salt	60
Hard lime	80

I have given the record exactly as received. It is well to remember that "slate" in the driller's vernacular stands for either slate or shale — here for shale.

The "granite," too, is probably, almost certainly, the lower part of the Corniferous limestone.

In its lower part, this record agrees with the general run of record in western New York. Above the salt there are usually 25 to 200 feet of shales — sometimes omitted — then 200 to 300 feet of (L. H.) limestones; then usually a thin, soft layer in the place of the Oriskany; then from 140 to 150 feet of Corniferous. The Hamilton proper below Genesee shale in the Genesee valley is about 600 feet. (See in my salt report of 1885 remarks on the Lackawanna well.)

The 248 feet above the salt are probably partly Salina; but as we have no certain knowledge of the division between the two periods it may be best to put it down as Lower Helderberg and Salina. If we attach only one name, it should be Lower Helderberg.

Limestone lies directly upon the salt in several wells where we have been obliged to call it so. The 60 to 80 feet above I think are without doubt Corniferous and the 620 above are certainly Hamilton. Whether the shales above belong in part to the Hamilton proper I do not pretend to say.

This is a very important record, as it extends our knowledge of the salt bed some miles south. By comparing this with the Nunda record the inference that the salt bed is a syncline with the deepest part in the Ithaca, Castile line, is very strong.

NAMES AND LOCATIONS OF SALT COMPANIES.

NAME.	Location.	Process.	Number of wells.
Alex. Kerr Bros. & Co	Rock Glen	Grainer and pans	7
Bradley Salt Co	Warsaw	Grainer	
Castile Salt Works	Castile	Pans	2
Crystal Salt Co	Saltvale	Large pans	
Dansville Oil, Gas and Mining Co			
Duncan Salt Co	Silver Springs	Vacuum pans and grainer	5
Empire Salt Co	Warsaw	Grainer	4
Genesee Salt Co	Piffard	Large pans	4
Globe Salt Co	Wyoming	Small pans	
Guinlock & Humphrey	Warsaw	Large pans	
Hawley Salt Co	Warsaw	Large pans	
Humphrey & Calkins	Pavilion		2
Lackawanna Salt Co	Mt. Morris	Grainer	2
Leicester Salt Works	Cuylerville	Small pans	1
Leroy Salt Co	Leroy	Grainer	9
Livingston Salt Co	Piffard	Grainer	
Miller Salt Co	Warsaw	Kettles with steam jackets	
National Salt and Chemical Co	Lakeville		3
Pearl Salt Co	Pearl Creek	Grainer	2
Perry Salt Co	Perry	Grainer	2
Retsof Salt Mining Co			
Royal Salt Co	Mt. Morris	Grainer	3
Standard Salt Co	Warsaw	Kettles with steam jackets	1
Warsaw Salt Co	Warsaw	Large pans	6
York Salt Co	York	Grainer	2

Of these the National and the Leicester works are not now in operation, but the officers report that they will be by January, 1892. The total capacity of all the factories is, in round numbers, about 3,000,000 barrels per annum. I should estimate 2,000,000 barrels as a fair estimate of the total production of the western New York salt field, especially if the product of the Retsof mine be included.

ADDITIONAL NOTES.

A modification of the vacuum process, as employed in sugar making, is in use at the Duncan works, Silver Springs. The salt obtained is of excellent quality ; fine, loose, and free from moisture.

Crude petroleum is used as fuel by the Crystal Company. The cost is said to be greater, but the saving in labor is sufficient to make up the deficiency. Others, as the Miller Salt Company, have abandoned its use as too expensive.

The Standard Company reports the following experiments, with bituminous coal as a source of heat for evaporating brine :

March, 15 36–100 tons of coal made 170 barrels of salt.
January, 14 2–5 tons of coal made 170 barrels of salt.

REPORT

OF THE

STATE BOTANIST

1891

REPORT OF THE STATE BOTANIST

To the Honorable the Regents of the University of the State of New York:

Gentlemen.— I have the honor of communicating to you the following report:

Specimens of plants for the State Herbarium have been collected in the counties of Albany, Cattaraugus, Cayuga, Cortland, Essex, Fulton, Hamilton, Rensselaer, Saratoga, Seneca, Tompkins, Ulster and Wayne.

Specimens have been contributed by correspondents who collected them in the counties of Albany, Orleans, Onondaga, Rensselaer, Richmond, St. Lawrence, Sullivan, Tompkins and Wayne.

Specimens representing 165 species have been added to the Herbarium during the past year, of which 154 were collected by the Botanist and 11 were contributed. Of the former number 29 were not before represented in the Herbarium, and six of these are new or undescribed species. Of the 11 contributed species, five were not before represented. The increase in the number of species represented is 34. The remaining specimens show some variety or form which was lacking in the Herbarium or serve to improve or make more complete the representation of their respective species.

A list of the species of which specimens have been added to the Herbarium is marked A. Appended to this list are the names of 37 species of trees of which specimens have been collected. These are intended to accompany the collection of wood sections taken from the trunks.

Specimens have been contributed by 23 persons. Among the contributed specimens are many extra-limital species not included in the foregoing enumeration.

Among the contributions is a volume of dried specimens of Carices which is of much interest. It was kindly presented to the State Museum by Mrs. Gould of Hudson and contains examples of about 150 species. It bears the inscription "Carices

Americæ Septentrionalis Exsiccatæ. Edidit H. P. Sartwell M. D., Pars I. II. Penn Yan, Nov. Ebor. 1848. 50." Many of the specimens were collected in New York by Dr. Sartwell himself, but there are contributions from such eminent botanists (most of whom, alas! are now dead) as Dewey, Tuckerman, Oakes, Gray, Wood, Chapman, Carey, Olney, Crawe, Sullivant, Mead, Vasey, Kneiskern, Curtis, Cooley and Hale. There are specimens from Massachusetts, Rhode Island, New Jersey, North and South Carolina, Florida, Louisiana, Ohio, Illinois, Michigan and the White Mountains of New Hampshire. Some of the species represented are quite rare and the printed labels show us how all of them were understood by these master minds in those early days of American caricography.

Another contribution worthy of special notice is that of Professor Eaton of New Haven. It is a collection of ferns made in the Island of Trinidad by Mr. Augustus Fendler and commonly known as "Fendler's Ferns of Trinidad." The luxuriant and beautiful ferns of tropical regions are always full of interest to students of this branch of botany, and these will greatly aid those who may wish to study the ferns of our conservatories. A list of contributors and their respective contributions is marked B.

A record of species not before reported by me and descriptions of such as are thought to be new will be found in a part of the report marked C.

I have added to this the descriptions of seven extra-limital species that were sent to me for identification but of which no description was found.

Remarks concerning species previously reported, a record of new localities of rare plants and descriptions of new varieties may be found in a part of the report marked D.

Following a plan previously adopted, the descriptions of our New York species of Omphalia have been revised and rewritten and the spores examined and their dimensions included so that the identification of our species may be made more easy, certain and satisfactory. These descriptions may be found in a part of the report marked E.

In accordance with my instructions the work of preparing life-size drawings of our edible and poisonous species of fleshy fungi, colored according to nature, has been commenced. At the present time twenty plates have been completed and five others are partly done. About forty plates will be needed to illustrate the species satisfactorily. Except in case of some of the smaller species, an entire plate is devoted to a single species, so that its variations in size and color may be shown. The plates are 9 x 12, or 7½ x 9½ within the marginal lines. It has been my purpose to make a personal trial of all the edible species illustrated so that it may be possible for me to speak with confidence concerning their qualities. With two or three exceptions this has been done with the species already figured, and these exceptions will be tried as soon as opportunity is afforded. From the eagerness with which literature pertaining to and illustrations of edible and poisonous fungi are sought and from the numerous inquiries received by me concering the edible qualities of specimens sent in for identification it is clearly manifest that there is a widespread and increasing desire among our people to understand more of this subject and to be able to distinguish with confidence the good species. I am sure therefore that any well-directed and faithful efforts to meet this demand and to give reliable information on this subject will be well received and highly appreciated.

Some observations of no little interest have been made upon some of the parasitic fungi. A minute grayish mold-like fungus, known to mycologists as *Botrytis vulgaris* is quite common. It is classed among the saprophytes, and its habitat is given as "decaying herbs, fruits, flowers, twigs and leaves." My observations lead to the conclusion that it often acts as a true parasite. It is common enough on the fruit of strawberry, raspberry and blackberry plants. It spreads rapidly in favorable weather from the affected to the sound fruit. If a sound berry is in contact with one affected by this fungus a discolored decaying spot soon appears at the point of contact, showing clearly that the mycelium of the fungus has passed from the diseased berry to the sound one and penetrated its tissues. In this way the contagion will quickly extend through all the berries of the cluster, provided they touch each other and the diseased ones are allowed to remain in place. The fungus quickly produces rot or decay in the berry it attacks but it has no hesitation in attacking perfectly sound and healthy fruit.

The "fruit oidium," *Monilia fructigena*, which has recently been called the "peach rot," is similar to the preceding one in color but very different in structure. It also was regarded by the earlier botanists as a saprophyte, but it also is now known to be a real and a very destructive parasite. The habitat usually ascribed to it in the books is "decaying fruits," but Professors Arthur and Smith have both shown most conclusively that it attacks sound and healthy fruits and that it induces that decay in them which was formerly thought to be a condition of its growth. My observations confirm what they have said of this fungus and show very clearly some of the contributing causes to its ravages. It is well known that its behavior is especially malignant in wet weather and that it works with most destructive force on peaches, plums and cherries, though frequently attacking also, apples, pears and quinces. The past season, cherries with us almost entirely escaped for the simple reason that dry weather prevailed up to the time of their ripening. Plums and peaches on my grounds were fully one-half destroyed by this fungus, but at the time they were maturing wet, cloudy and rainy weather prevailed. One plum tree maturing its fruit later than the others had many diseased fruits while the wet weather lasted, but the trouble was greatly diminished after the rains ceased. Then even the fruit that had cracked open escaped attack.

Insects that eat holes in the fruit are a contributing cause. The only quince on my grounds that I have thus far seen affected was one in the side of which some insect had eaten a small hole and then left it. The aperture was very shallow, but the fungus spores gained admission to the flesh by it and immediately produced the characteristic decayed brown spot all about it as a center of infection. Very many of the affected peaches first showed the presence of the fungus on the side where small holes had been made through the peel, apparently by some small insect, though I was not able to detect any insect in the act. Honey bees in great numbers were found sucking the juice of the peach from these little cavities, and not a few striped cucumber beetles were found in them feeding upon the juicy flesh of the peach. Whenever peaches as well as plums were in contact, an affected one would quickly transmit its disease to its sound neighbor through the point of contact, which is a strong argument for the proper thinning of fruit. Peaches sometimes transmit the disease, through the agency of the mycelium of the fungus, to the branch that sustains them, and then the branch soon withers and dies. This may be prevented by promptly removing the affected peaches. But sometimes young and tender branches are killed by an attack through the agency of the spores. On a young plum tree the tips of several branches on which there were no plums died and showed the characteristic spore clusters of this fungus on their surface. A young apricot tree, on which there was no fruit, lost the tips of many of its branches by the invasion of this same fungus. New shoots started, but during a renewal of the rainy weather the attack was repeated and these were in like manner killed. The fungus is certainly one capable of doing a vast amount of mischief; nor is it to be overcome by picking and destroying the affected fruit and twigs unless this is promptly done by every one in an affected district, for if the trees of one orchard or garden are cleared, the spores are quickly wafted to them again by the winds from any neglected neighboring orchard or tree.

Another minute mold-like fungus, *Rhopalomyces Cucurbitarum*, has "putrid squashes" recorded as its habitat. But in this case, as in the others, the fungus is itself the cause of the putridity in the squashes, not a consequence. Young but sound squashes scarcely out of blossom are attacked by it and quickly reduced to a pulpy putrid mass. Mature squashes are less often injured or destroyed by it unless there is a contributing cause. Sometimes centipedes eat cavities in the under side of a squash where it is in contact with the earth. Through these cavities the fungus spores gain access and quickly reduce the squash to a worthless putrid mass.

Very respectfully submitted.

CHAS. H. PECK.

Albany, *October* 1, 1891.

A.

PLANTS ADDED TO THE HERBARIUM.

New to the Herbarium.

Cardamine rotundifolia *Mx.*
Stellaria graminea *L.*
Ailanthus glandulosus *Desf.*
Aster Herveyi *Gr.*
Lysimachia nummularia *L.*
Plantago Patagonica *Jacq.*
Carya sulcata *Nutt.*
Carex æstivalis *M. A. C.*
Panicum miliaceum *L.*
Clitopilus carneo-albus *With.*
Leptonia parva *Pk.*
L. grisea *Pk.*
Galera flava *Pk.*
Agaricus hæmorrhoidarius *Schulz.*
Hypholoma subaquilum *Banning.*
Russula roseipes *Bres.*
Dædalea quercina *Fr.*
Septoria podophyllina *Pk.*
Glœosporium populinum *Pk.*
G. allantoideum *Pk.*
G. nervisequum *Sacc.*
Puccinia Zopfii *Wint.*
Ustilago Tritici *Jens.*
U. Hordei *K. & S.*
Doassansia Martianoffiana *Schroet.*
Entyloma Physalidis. *Wint.*
Peronospora Rubi *Rabh.*
P. obovata *Bon.*
Sporotrichum parasiticum *Pk.*
Pseudopeziza Medicaginis *Sacc.*
Sphærotheca mors-uvæ *B. & C.*
S. Humuli *Burrill.*
Erysiphe Galeopsidis *DC.*

Not new to the Herbarium.

Anemone Virginiana *L.*
Magnolia acuminata *L.*
Cardamine rhomboidea *DC.*
Nasturtium lacustre *Gr.*
Hudsonia tomentosa *Nutt.*
Viola cucullata *Ait.*
V. sagittata *Ait.*
V. renifolia *Gr.*
V. pub. var. scabriuscula *T. & G.*
Dianthus Armeria *L.*
D. barbatus L.
Lychnis Flos-cuculi *L.*
Stellaria longipes *Goldie.*
Hypericum perforatum *L.*
Tilia Americana *L.*
Oxalis Acetosella *L.*
Acer sacch. var. nigrum *T. & G.*
Rubus Canadensis *L.*
Fragaria Indica *L.*
Poterium Canadense *B. & H.*
Pyrus communis *L.*
P. Malus *L.*
P. sambucifolia *C. & S.*
Thaspium barbinode *Nutt.*
Cicuta bulbifera *L.*
Conium maculatum *L.*
Galium trifidum *L.*
Solidago bic. var. concolor *T. & G.*
S. puberula *Nutt.*
S. uliginosa *Nutt.*
S. speciosa *Nutt.*
S. arguta *Ait.*
Aster undulatus *L.*
A. cord. var. lævigatus *Porter.*
A. vimineus *Lam.*
A. diffusus *Ait.*
A. paniculatus *Lam.*
A. Novi-Belgii *L.*
A. puniceus *L.*
Erigeron stri. var. discoideus *Rob.*
Antennaria plantaginifolia *Hook.*
Lampsana communis *L.*
Cirsium arvense *Hoffm.*
Vaccinium corymbosum *L.*
Lysimachia stricta *Ait.*
L. strict. var. producta *Gr.*
Asclepias incarnata *L.*
Halenia deflexa *Gris.*
Phlox divaricata *L.*
Polemonium reptans *L.*

Pentstemon lævigatus *Soland.*
Verbena urticifolia *L.*
V. hastata *L.*
Polygonella articulata *Meisn.*
Juglans nigra *L.*
Carya amara *Nutt.*
C. microcarpa *Nutt.*
Betula nigra *L.*
Quercus palustris *DuRoi.*
Salix nigra *Marsh.*
S. amygdaloides *And.*
Populus balsamifera *L.*
Corallorhiza innata *R. Br.*
Clintonia umbellata *Torr.*
Erythronium Americanum *Ker.*
Trillium grandiflorum *Salish.*
Sagittaria vari. var. gracilis *Eng.*
Cyperus dentatus *Torr.*
Eriophorum vaginatum *L.*
Eleocharis tuberculosa *R. Br.*
Juncus Balt. var. littoralis *Eng.*
Scirpus atrovirens *Muhl.*
S. microcarpus *Presl.*
S. sylvaticus *L.*
S. polyph. var. macrostachys *Bœckl.*
Carex Grayii *Carey.*
C. utric. var. minor *Boott.*
C. hystricina *Muhl.*
C. riparia *Curt.*
C, triceps *Mx.*
C. gracillima *Schw.*
C. Œderi *Ehrh.*
C. laxiflora *Lam.*
C. pubescens *Muhl.*
C. alopecoidea *Tuckm.*
C. rosea var. radiata *Dew.*
C. varia *Muhl.*
C. echinata *Murr.*
C. trisperma *Dew.*
Panicum latifolium *L.*
P. Crus-galli *L.*
Muhlenbergia sobolifera *Trin.*
M. sylvatica *T. & G.*

Agrostis vulgaris *With.*
Poa comp. var. sylvestris *Torr.*
Agropyrum caninum *R. & S.*
Festuca nutans *Willd.*
Botrychium ternatum *Sw.*
Amanita cæsarea *Scop.*
Lepiota rhacodes *Vitt.*
Tricholoma album *Fr.*
T. personatum *Fr.*
Clitocybe cyathiformis *Fr.*
Collybia Familia *Pk.*
Mycena galericulata *Scop.*
Pholiota discolor *Pk.*
Hebeloma crustuliniformis *Bull.*
Agaricus sylvicola *Fr.*
Stropharia squamosa *Fr.*
Psilocybe spadicea *Fr.*
Cortinarius collinitus *Fr.*
Hygrophorus splendens *Pk.*
H. pratensis *Fr.*
Cantharellus lutescens *Bull.*
Marasmius erythropus *Fr.*
Boletus punctipes *Pk.*
Polyporus brumalis *Fr.*
Poria sanguinolenta *Fr.*
Dædalea unicolor *Fr.*
Hydnum pallidum *C. & E.*
H. stipatum *Fr.*
Irpex Tulipifera *Schw.*
Corticium lacteum *Fr.*
Coniophora puteana *Fr.*
Tremella mesenterica *Retz.*
Glœosporium lagenarium *S. & K.*
Ramularia variabilis *Fckl.*
R. lineola *Pk.*
Bactridium flavum *K. & S.*
Zygodesmus fuscus *Cd.*
Fusarium Solani *Sacc.*
Tubercularia persicina *Sacc.*
Cystopus candidus *Lev.*
Vibrissea truncorum *Fr.*
Peziza chlora *Schw.*
Melogramma vagans *DeNot.*

Specimens from Trees.

Magnolia acuminata *L.*
Tilia Americana *L.*
Acer saccharinum *Wang.*
A. sacch. var. nigrum *T. & G.*
A. dasycarpum *Ehrh.*

Betula lenta *L.*
B. populifolia *Ait.*
B. papyrifera *Marsh.*
B. nigra *L.*
Ostrya Virginica *Willd.*

Prunus Pennsylvanica *L.*
P. serotina *Ehrh.*
Ulmus fulva *Mx.*
U. Americana *L.*
U. racemosa *Thomas.*
Celtis occidentalis *L.*
Morus rubra *L.*
Platanus occidentalis *L.*
Juglans nigra *L.*
J. cinera *L.*
Carya sulcata *Nutt.*
C. porcina *Nutt.*
C. amara *Nutt.*
Quercus palustris *DuRoi.*
Betula lutea *Mx.*
Carpinus Caroliniana *Walt.*
Fagus ferruginea *Ait.*
Castanea sat. var. Americana *Mx.*
Salix nigra *Marsh.*
Populus balsamifera *L.*
P. bal. var. candicans *Gr.*
P. monilifera *Ait.*
Pinus Strobus *L.*
P. rigida *Mill.*
P. resinosa *Ait.*
Abies balsamea *Mill.*
Larix Americana *Mx.*
Thuya occidentalis *L.*
Juniperus Virginiana *L.*

B.

CONTRIBUTORS AND THEIR CONTRIBUTIONS.

Mrs. Hannah Gould, Hudson, N. Y.

Carex glaucescens, *Ell.*
C. longirostris *Torr.*
C. oligosperma *Mx.*
C. Tuckermani *Boott.*
C. bullata *Schk.*
C. ampullacea *Good.*
C. monile *Tuckm.*
C. Schweinitzii *Dew.*
C. retrorsa *Schw.*
C. stenolepis *Torr.*
C. squarrosa *L.*
C. lupuliformis *Sart.*
C. lupulina *Muhl.*
C. subulata *Mx.*
C. turgescens *Torr.*
C. rostrata *Mx.*
C. folliculata *L.*
C. Elliottii *S. & T.*
C. Grayii *Carey.*
C. intumescens *Rudge.*
C. tentaculata *Muhl.*
C. hystricina *Willd.*
C. pseudo-cyperus *L.*
C. comosa *Boott.*
C. trichocarpa *Muhl.*
C. aristata *R. Br.*
C. lacustris *Willd.*
C. striata *Mx.*
C. Halseyana *Dew.*
C. vestita *Willd.*
Carex eburnea *Boott.*
C. Hitchcockiana *Dew.*
C. oligocarpa *Schk.*
C. ignota *Dew.*
C. blanda *Dew.*
C. laxiflora *Lam.*
C. digitalis *Willd.*
C. retrocurva *Dew.*
C. platyphylla.
C. Careyana *Dew.*
C. plantaginea *Lam.*
C. hirsuta *Willd.*
C. virescens *Muhl.*
C. gracillima *Schw.*
C. formosa *Dew.*
C. Davisii *S. & T.*
C. flaccosperma *Dew.*
C. grisea *Wahl.*
C. conoidea *Schk.*
C. pallescens *L.*
C. Meadii *Dew.*
C. Woodii *Dew.*
C. crinita *Lam.*
C. cephaloidea *Dew.*
C. alopecoidea *Tuckm.*
C. Leavenworthii *Dew.*
C. scabrior *Sart.*
C. disticha *Huds.*
C. granularis *Muhl.*
C. Crawei *Dew.*

Carex lanuginosa *Mx.*
C. filiformis *L.*
C. Œderi *Ehrh.*
C. flava *L.*
C. Cherokeënsis *Schw.*
C. flexilis *Rudge.*
C. capillaris *L.*
C. venusta *Dew.*
C. debilis *Mx.*
C. arctata *Boott.*
C. Sullivantii *Boott.*
C. scabrata *Schw.*
C. miliacea *Muhl.*
C. Chapmani *Sart.*
C. pubescens *Muhl.*
C. præcox *Jacq.*
C. Richardsoni *R. Br.*
C. varia *Muhl.*
C. Pennsylvanica *Lam.*
C. lucorum *Willd.*
C. Emmonsii *Dew.*
C. umbellata *Schk.*
C. Baltzellii *Chapm.*
C. pedunculata *Muhl.*
C. cristata *S. & T.*
C. lagopodioides *Schk.*
C. scoparia *Schk.*
C. Liddoni *Boott.*
C. arida *S. & T.*
C. sycnocephala *Carey.*
C. sterilis *Schk.*
C. scirpoides *Schk.*
C. Deweyana *Schw.*
C. stellulata *Good.*
C. sphærostachya *Dew.*
C. canescens *L.*
C. tenuiflora *Wahl.*
C. trisperma *Dew.*
C. gracilis *Ehrh.*
C. Fraseri *Sims.*
C. chordorhiza *Ehrh.*
C. retroflexa *Muhl.*
C. rosea *Schk.*
C. Muhlenbergii *Schk.*
C. cephalophora *Muhl.*
Carex tetanica *Schk.*
C. panicea *L.*
C. livida *Willd.*
C. aurea *Nutt.*
C. Shortiana *Dew.*
C. atrata *L.*
C. Buxbaumii *Wahl.*
C. irrigua *Sm.*
C. limosa *L.*
C. flacca *Schreb.*
C. salina *Wahl.*
C. aquatilis *Wahl.*
C. stricta *Lam.*
C. strictior *Dew.*
C. acuta *L.*
C. vulgaris *Fr.*
C. torta *Boott.*
C. rigida v. Bigelovii *Tuckm.*
C. straminea *Schk.*
C. alata *Torr.*
C. fœnea *Muhl.*
C. mirabilis *Dew.*
C. tenera *Dew.*
C. festucacea *Schk.*
C. cephaloidea *Dew.*
C. sparganioides *Muhl.*
C. stipata *Muhl.*
C. alopecoidea *Tuckm.*
C. Crus-corvi *Shutt.*
C. decomposita *Muhl.*
C. vulpinoidea *Mx.*
C. prairiea *Dew.*
C. Sartwellii *Dew.*
C. teretiuscula *Good.*
C. siccata *Dew.*
C. Backii *Boott.*
C. Steudelii *Kunth.*
C. Willdenowii *Schk.*
C. bromoides *Schk.*
C. polytrichoides *Muhl.*
C. pauciflora *Light.*
C. capitata *L.*
C. scirpoidea *Mx.*
C. dioica *L.*

Mrs. E. C. Anthony, Gouverneur, N. Y.

Viola cucullata *Ait.*

Mrs. L. L. Goodrich, Syracuse, N. Y.

Fragaria Indica *L.*

Prof. D. C. Eaton, New Haven, Conn.

Adiantum Kaulfussii *Kze.*
A. intermedium *Sw.*
A. tetraphyllum *Willd.*
A. pulverulentum *L.*
A. lucidum *Sw.*
A. villosum *L.*
A. macrophyllum *Sw.*
A. tenerum *Sw.*
A. obtusum *Desv.*
A. polyphyllum *Willd.*
Aspidium molle *Sw.*
A. macrophyllum *Sw.*
A. subquinquefidum *Bv.*
A. invisum *Sw.*
A. amplum *Mett.*
A. melagodes *Mett.*
A. Sprengelii *Kaulf.*
A. semicordatum *Sw.*
A. trifoliatum *Sw.*
A. effusum *Gris.*
A. Imrayanum *Fee.*
Asplenium Shepherdi *Spreng.*
A. grandifolium *Sw.*
A. lunulatum *Sw.*
A. crenulatum *Baker.*
A. cultrifolium *L.*
Aneimia Phyllitidis *Sw.*
A. Breuteliana *Presl.*
Acrostichum sorbifolium *L.*
A. osmundaceum *Hook.*
A. flaccidum *Fee.*
A. cervinum *L.*
A. nicotianifolium *Sw.*
A. caudatum *Hook.*
Alsophila nitens *Sm.*
A. ferox *Presl.*
A. blechnoides *Hook.*
Blechnum occidentale *L.*
B. longifolium *H. B. K.*
B. volubile *Kaulf.*
Cheilanthes radiata *R. Br.*
Cyathea Schanshin *Mart.*
Danæa elliptica *Sm.*
Davallia inæqualis *Kze.*
D. saccoloma *Spreng.*
Dicksonia cicutaria *Sw.*
Gymnogramme calomelanos *Kaulf.*
Gleichenia pubescens *H. B. K.*
G. pectinata *Presl.*
Hemionitis palmata *L.*
Hemitelia grandifolia *Spreng.*
Hymenophyllum ciliatum *Sw.*
Hypoderris Brownii *Sm.*
Lindsæa stricta *Dry.*
L. trapeziformis *Dry.*
Lygodium venustum *Sw.*
L. volubile *Sw.*
Meniscium reticulatum *Sw.*
Nephrolepis acuta *Presl.*
N. exaltata *Presl.*
Oleandra nodosa *Presl.*
O. neriiformis *Cav.*
Phegopteris crenata *Mett.*
P. flavopunctata *Fee.*
Pteris pungens *Willd.*
P. aquil. v. esculenta *H. & B.*
Polypodium aureum *L.*
P. incanum *Sw.*
P. neriifolium *Schk.*
P. vacciniifolium *L.*
P. nematorhizon *Eaton*
P. serrulatum *Mett.*
P. lycopodioides *L.*
P. piloselloides *H. & B.*
Trichomanes crispum *L.*
T. pinnatum *Hedw.*
T. sinuosum *Rich.*
T. membranaceum *L.*
T. Prieurii *Kye.*
T. spicatum *Hedw.*
Lycopodium cernuum *Lve.*
Selaginella patula *Spreng.*
S. serpens *Spreng.*

Prof. N. L. Britton, New York, N. Y.

Nymphæa reniformis *DC.*
Nelumbium nuciferum *Gœrt.*
Lathyrus maritimus *Bigel.*
Aster cordifolius *L.*
Vaccinium vacillans *Sibth.*
V. Pennsylvanicum *Lam.*
Vaccinium corymbosum *L.*
V. disocarpum *Bigel.*
Halenia deflexa *Gris.*
Carya microcarpa *Nutt.*
Juncus Balticus *Deth.*
Eleocharis tuberculosa *R. Br.*

Prof. B. D. Halsted, New Brunswick, N. J.

Peronospora Rubi *Rabh.*
P. alta *Fckl.*
P. obovata *Bon.*
Peronospora parasitica *DeBy.*
Plasmopara viticola *B. & C.*
Puccinia Spergulæ *DC.*

Rev. F. D. Kelsey, Helena, Mont.

Phragmidium subcorticium *Wint.*
Puccinia intermixta *Pk.*
P. Tanaceti *DC.*
P. Menthæ *Pers.*
P. Malvastri *Pk.*
P. Troximontis *Pk.*
P. Giliæ *Hark.*
P. Phragmitis *Korn.*
P. mirabillissima *Pk.*
P. emaculata *Schw.*
P. Thlaspeos *Schub.*
P. Hieracii *Mart.*
Uromyces Eriogoni *E. & H.*
U. Trifolii *Lev.*
U. borealis *Pk.*
Ustilago segetum *Dittm.*
Melanospora farinosa *Pers.*
M. Cerastii *Schroet.*
M. Lini *Tul.*
Coleosporium Solidaginis *Thum.*
Cronartium Comandræ *Pk.*
Rœstelia lacerata *Tul.*
Cystopus candidus *Lev.*
Ramularia arnicalis *E. & E.*
Æcidium Pini *Pers.*
Æ. Clematidis *DC.*
Æ. Ranunculacearum *DC.*
Æ. porosum *Pk.*
Æ. Allenii *Clint.*
Æ. Cleomis *E. & A.*
Æ. Asterum *Schw.*
Æ. Violæ *Schum*
Æ. Compositarum *Mart.*
Æ. Thalictri *Grev.*
Æ. Eurotiæ *E. & E.*
Æ. gaurinum *Pk.*
Æ. monoicum *Pk.*
Æ. Plantaginis *Cke.*
Erysiphe communis *Wallr.*
E. Cichoracearum *DC.*
Sphærotheca Castagnei *Lev.*
Phyllactinia suffulta *Reb.*
Microsphæria Ravenelii *B.*
Valsa boreella *Karst.*
Physalospora megastoma *Sacc.*
Leptosphæria Typharum *Desm.*
Phyllachora Wittrockii *Erik.*

C. L. Shear, Alcove, N. Y.

Agaricus placomyces *Pk.*
Plantago Patagonica *Jacq.*

E. W. D. Holway, Decorah, Ia.

Puccinia Zopfii *Wint.*
P. Rhodiola *B. & Br.*
Uromyces perigynius *Halsted.*
Entyloma Castaliæ *Holway.*
E. Yuccæfoliæ *Holway.*

P. H. Dudley, New York, N. Y.

Xylaria Hypoxylon *Fr.*
Trametes Pini *Fr.*

A. P. Morgan, Preston, O.

Tilmadoche columbina *Berk.*
Cornuvia elegans *Morg.*
Physarum albicans *Pk.*
Dermodium conicum *Pers.*

Roland Thaxter, New Haven, Conn.

Rhopalomyces strangulatus *Thax.*
Sporotrichum globuliferum *Speg.*

J. B. Ellis, Newfield, N. J.

Cercospora Asiminæ *E. & K.*

Chas. L. Williams, Glens Falls, N. Y.

Lysimachia stricta *Ait.* var. producta *Gr.*

Prof. S. M. Tracy, Agricultural College, Miss.

By exchange.

Agropyrum tenerum *Vasey.*
A. glaucum *R. & S.*
A. divergens *Nees.*
Avena flavescens *L.*
A. pratensis *L.*
A. sterilis *L.*
Aristida stricta *Mx.*
A. stipoides *R. Br.*
A. oligantha *Mx.*
Alopecurus agrestis *L.*
Anthænantia rufa *Benth.*
A. villosa *Bv.*
Bromus erectus *Huds.*
Bouteloua hirsuta *Lag.*
Beekmannia erucæformis *Huds.*
Cynosurus echinatus *L.*
Cottea pappaphoroides *Kth.*
Chloris acicularis *R. Br.*
C. Swartziana *Dœll.*
Ctenium Americanum *Spreng.*
Coix lachryma *L.*
Diplachne Tracyi *Vasey.*
D. imbricata *Vasey.*
Deyeuxia neglecta *Kth.*
Elymus Macounii *Vasey.*
Eragrostis campestris *Tris.*
Eatonia obtusata *Gr.*
Eleusine Ægyptiaca *Pers.*
Erianthus saccharoides *Mx.*
Festuca elatior *L.*
Glyceria distans *Wahl.*
Hordeum murinum *L.*
Kœleria cristata *Pers.*
Leptochloa mucronata *Kth.*
Leersia hexandra *Sw.*
Munroa squarrosa *Torr.*
Oryzopsis cuspidata *Benth.*
Oplismenus setarius *R. & S.*
Poa tenuiflora *Nutt.*
P. Traceyi *Vasey.*
P. alpina *L.*
P. compressa *L.*
P. gracillima *Vasey.*
P. flexuosa *Muhl.*
P. cenisia *All.*
P. cæsia *Sm.*
Poppophorum Wrightii *Wats.*
Polypogon maritimus *L.*
Phleum alpinum *L.*
Panicum viscidum *Ell.*
P. serotinum *Trin.*
P. scoparium *Lam.*
P. Palmeri *Vasey.*
P. obtusum *H. B. K.*
P. microcarpum *Muhl.*
P. glabrum *Ell.*
P. effusum *R. Br.*
P. dichotmum v. viride *Vasey.*
P. autumnale *Bosc.*
P. commutatum *Sch.*
Paspalum dilatatum *Poir.*
P. Floridanum *Mx.*
P. platycaule *Poir.*
P, purpurascens *Ell.*
Roteboellia rugosa *Nutt.*
Schedonnardus Texanus *Steud.*
Setaria setosa *Bv.*
Sporobolus junceus *Kth.*
S. depauperatus *Vasey.*
S. ramulosus *Kth.*
S. asperifolius *N. & M.*
Tragus racemosus *Hall.*
Uniola paniculata *L.*

C. E. Fairman, M. D., Lyndonville, N. Y.

Glœosporium allantoideum *Pk.*
Rhizopus nigricans *Ehr.*

L. H. Cress, Fremont, Ohio.

Morchella conica *Pers.*

E. L. Hankenson, Newark, N. Y.

Lychnis Flos-cuculi *L.*
Lampsana communis *L.*

F. L. Henderson, Olympia, Wash.

Mycena strobilinoidea *Pk.*
Exobasidium Cassiopes *Pk.*
Nidularia candida *Pk.*

M. E. Jones, Salt Lake City, Utah.

Septoria Peraphylli *Pk.*
Uromyces deciduus *Pk.*

F. L. Hervey, Orono, Maine.

Clavaria Herveyi *Pk.*

C. F. Millspaugh, Morganstown, W. Va.

Septosporium Equiseti *Pk.*

Prof. W. R. Dudley, Ithaca, N. Y.

Pentstemon lævigatus *Sol.*

Arthur M. Peck, Sandlake, N. Y.

Populus balsamifera *L.*

(C.)

PLANTS NOT BEFORE REPORTED.

Cardamine rotundifolia *Mx.*

Springy and wet places. Carrollton, Cattaraugus county. June.

New Jersey and Pennsylvania have heretofore been considered the northern limit of this plant, but it is plentiful in at least two localities near Carrollton.

Stellaria graminea *L.*

Roadsides. Sandlake, Rensselaer county; New Scotland, Albany county. June and July. A pretty little species introduced from Europe and resembling somewhat the native species, *S. longifolia* and *S. longipes*, but distinct from both by its leaves and rough seeds.

Ailanthus glandulosus *Desf.*

Roadsides and waste places. Long Island; Cold Spring, Putnam county; Marlborough, Ulster county. This rapid-growing tree, introduced from China, often springs up spontaneously by roadsides and in waste places about cities and villages. It has been represented to me as spreading so rapidly in some places that it is troublesome.

Aster Herveyi *Gray.*

Borders of woods. Salamanca, Cattaraugus county. September.

This species might easily be taken for a bright violet-rayed form of *A. macrophyllus*, but it differs from that species in its glandular pubescent floral branches and peduncles.

Lysimachia nummularia *L.*

Wilton, Saratoga county. July. Introduced and escaped from cultivation.

Plantago Patagonica *Jacq.* var. aristata *Gr.*

Sandy fields. Alcove, Albany county. August. *C. L. Shear.* Probably a recent introduction.

Carya sulcata *Nutt*

Alluvial soil along the inlet of Owasco lake. July.

This hickory was first observed in this locality by Professor Dudley. The trees are not numerous but thrifty. Their leaves are very large, some of them measuring nearly two feet in length including the petiole. The terminal leaflet measures ten to twelve inches long and three to three and a half inches broad in the dried specimens. Withered aments were seen but no young fruit.

Carex æstivalis *M. A. C.*

Woods. East Worcester, Otsego county. July.

This plant somewhat resembles slender forms of *Carex arctata*, but from that species it may be distinguished by its more slender and erect spikes, its less pointed perigynia, shorter scales and by the pistillate flowers or perigynia at the top of the staminate spike.

Panicum miliaceum *L.*

Ithaca. *Professor Dudley.* Todt Hill road, near the Moravian church, Richmond county. *A. Hollick.* This millet has been introduced and is occasionally spontaneous. It is a beautiful and an interesting grass.

Clitopilus carneo-albus *With.*

Shaded ground. Menands. June.

Leptonia parva *n. sp.*

Pileus thin, convex or nearly plane, umbilicate, slightly radiate-striate, violaceous-brown, the umbilicus darker and squamulose; lamellæ subdistant, adnate, whitish tinged with flesh-color; stem slender, glabrous, solid, colored like the pileus; spores irregular or angular, uninucleate, about .0003 in. long, .00025 broad.

Pileus about 6 lines broad; stem about 1 in. long, scarcely 1 line thick.

Woods. Lake Pleasant, Hamilton county. August.

The color of the pileus is almost exactly like that of dark-colored forms of *L. serrulata*, but its smaller size, whitish lamellæ without darker serrated edge and stem not punctate at the top separate it.

Leptonia grisea *n. sp.*

Pileus broadly convex or plane, umbilicate, striatulate when moist, glabrous except the squamulose umbilicus, grayish brown; lamellæ broad, subdistant, grayish; stem slender, hollow, glabrous, colored like the pileus; spores subglobose, angular, uninucleate, .0003 to .0004 inches in diameter.

Pileus 6 to 12 lines broad; stem 1.5 to 2.5 inches long, 1 line thick.

Among sphagnum and in wet woods, Lake Pleasant. August.

The species is easily known by its nearly uniform grayish color and its globose spores.

Galera flava *n. sp.*

Pileus thin, ovate or campanulate, obtuse, finely plicate-striate to the middle, yellow; lamellæ thin, narrow, close, adnate, at first whitish, then yellowish-cinnamon; stem equal or slightly tapering upward, hollow, sprinkled with white mealy particles, slightly striate at the top, white or slightly tinged with yellow; spores brownish-ferruginous, ovate or subelliptical, .0005 inches long; .0003 broad.

Pileus 6 to 12 lines broad; stem 2 to 3 inches long, 1 to 2 lines thick.

Damp vegetable mold in woods. Freeville, Tompkins county. July.

The pileus is moist or subhygrophanous, and when dry it appears to be sprinkled with shining atoms. The yellow epidermis sometimes breaks up into squamules.

Agaricus hæmorrhoidarius *Schulzer.*

Ground under hemlocks. Menands. August.

This species is easily known, when fresh, by wounds upon any part of it quickly changing to red, as if about to bleed. The habitat usually ascribed to it is "About the roots of oaks," but our specimens were found growing under a hemlock tree. Gillet gives Fries as the author of the species, Fries ascribes it to Kalchbrenner and Kalchbrenner to Schulzer.

The pileus is at first covered with a fawn-colored or tawny-brown tomentum which soon breaks up and forms scales. The flesh is white and the lamellæ are at first whitish, soon flesh-colored, then brown. The spores are brown, elliptical, .0002 to .00025 in. long, .00016 broad.

Hypholoma subaquilum *Banning.*

Decaying wood. Adirondack mountains. August and September.

This species is closely allied to *H. appendiculatum*, but may be separated by its darker color, and especially by the darker color of its lamellæ.

Russula roseipes *Bres.*

Under hemlock trees. Menands. August. It might easily be taken for a small form of *R. alutacea*, from which its more strongly striate-tuberculate margin distinguishes it. It is edible.

Dædalea quercina *Fr.*

Dead stumps and trunks of oak. Selkirk, Albany county. August.

Septoria podophyllina *Pk.*

Living and languishing leaves of mandrake, *Podophyllum peltatum.* Freeville. July.

Glœosporium nervisequum *Sacc.*

Living leaves of sycamore, *Platanus occidentalis.* McLean, Tompkins county. July.

This fungus attacks the foliage and young branches early in the season and is often quite injurious to the tree. It manifests its presence either by discolored spots which follow the principal veins of the leaf, or by producing broad and irregular brown patches in the leaf. When the attack is severe it kills the entire leaf or even the branch and all its leaves. Indeed, it is said sometimes to be fatal to the tree.

Glœosporium populinum *n. sp.*

Spots small, 1 to 2 lines broad, nearly orbicular, reddish-brown, often paler in the center and then appearing to be surrounded by a broad darker margin, paler on the lower surface; heaps of spores hypophyllous, either single and central or several more or less concentrically arranged; spores subcylindrical, often a little curved, supported by slender sporophores, oozing out and forming a reddish mass, .001 to .0016 in. long, about .00012 in. broad.

Living leaves of poplar, *Populus grandidentata.* Freeville. July.

This species may be distinguished from other species of Glœosporium growing on poplar, by its narrow elongated spores which are not much unlike those of some species of Septoria. From Cylindrosporium it is separated by the agglutinated spore mass. From *G. stenosporum,* which occurs in Kansas on leaves of *Populus monilifera,* it differs in its smaller darker-colored spots, and in its darker-colored spore-masses, which are hypophyllous, and in its longer and simple spores.

Glœosporium allantoideum *n. sp.*

Heaps minute, numerous; spores cylindrical, curved, obtuse, .0005 to .0008 in. long, oozing out and forming minute whitish masses which are concentrically arranged.

Rind of pumkin. Lyndonville. January. *C. E. Fairman.*

The heaps are sometimes overrun by mucedinous filaments. The species is distinguished from *G. lagenarium* by its curved spores.

Puccinia Zopfii *Wint.*

Living leaves of cowslips, *Caltha palustris.* Buffalo. *G. W. Clinton.*

In reviewing some specimens of Puccinia on leaves of *Caltha palustris* sent me several years ago by the late Judge Clinton, I find some belonging to this species. He also sent me the true *Puccinia Calthæ,* so that these species meet on common ground in the western part of the State.

Ustilago Tritici *Jensen.*

Heads of wheat, *Triticum vulgare.* Meadowdale, Albany county. June.

This and the next following species have by most writers been included with the smut on oats as mere forms or varieties of the one comprehensive species *Ustilago segetum.* But Jensen indicated their distinct character, and the investigations of Professors Kellerman and Swingle have confirmed his views.

Ustilago Hordei *K. & S.*

Heads of barley, *Hordeum vulgare.* Sevey, St. Lawrence county and McLean, Tompkins county. July.

Another species of smut, *Ustilago nuda* also occurs on barley, but I have seen no specimens of it. It differs from the present species in having less globose spores, with the epispore spiny and the color of the spores in the mass brown instead of black.

Doassansia Martianoffiana *Schrœt.*

Living leaves of pondweed. Near the outlet of Marl pond, Cortland county. July. The water in which the pondweed grew had evaporated and left the plants stretched upon the muddy soil. They were small and apparently dwarfed, and now being deprived of their normal quantity of water is it any wonder that they yielded to the attacks of their parasite?

Entyloma Physalidis *Wint.*

Living leaves of the viscid ground cherry, *Physalis Virginiana.* Menands. August.

Peronospora Rubi *Rabh.*

Living leaves of blackberry, *Rubus villosus.* Cold Spring, Long Island. July. *B. D. Halsted.*

Peronospora obovata *Bon.*

On corn spurry, *Spergula arvensis.* Liberty, Sullivan county. July. *Halsted.*

Sporotrichum parasiticum *n. sp.*

Effused, minute, white; hyphæ very slender and delicate, irregularly branched; spores numerous, minute, elliptical, .00012 to .00016 inches long, .00008 broad.

On excrescences of the black knot, *Plowrightia morbosa.* Menands. July.

This fungus forms a thin white coating over the surface of the excrescence. It is often quite conspicuous because of the dark color of the background. It attacks young as well as old black knots, and in the former case it apparently prevents the free formation of the perithecia of the black knot, and should therefore be regarded as a useful fungus. It is sometimes accompanied by *Trichothecium roseum.*

Septocylindrium scirpinum *n. sp.*

Forming minute, somewhat confluent, flocculent white tufts; spores narrowly fusiform, pointed at one or both ends, .0008 to 002. inches long, .00016 to .00025 broad, with one to six septa.

Dead spikelets of cotton grass, *Eriophorum cyperinum.* Lake Pleasant. August.

Pseudopeziza Medicaginis *Sacc.*

Living or languishing leaves of nonesuch, *Medicago lupulina.* Menands. July.

Sphærotheca mors-uvæ *B. & C.*

Fruit and leaves of gooseberry, *Ribes Cynosbati.* Sprakers, Montgomery county, and Bergen, Genesee county. June.

Sphærotheca Humuli *Burrill.*

Living leaves of agrimony, *Agrimonia Eupatoria.* Newburgh. Also of marsh five-finger, *Potentilla palustris.* Adirondack mountains. Specimens have also been collected on *Rubus odoratus*, *R. triflorus*, *Poterium Canadense* and *Physocarpus opulifolius* which apparently belong here.

Erysiphe Galeopsidis *DC.*

Living leaves of hemp nettle, *Galeopsis Tetrahit*, rough hedge nettle, *Stachys aspera*, mad dog skullcap, *Scutellaria lateriflora.* Tyre, Seneca county and Sandlake. August and September.

The following species are extra-limital. Specimens of them have been sent to me for identification, but I find no descriptions that harmonize with their characters. They are therefore recorded here as new species.

Mycena strobilinoidea *n. sp.*

Pileus thin, subcampanulate, obtuse, glabrous, bright scarlet; lamellæ whitish, reddish on the edge; stem short, glabrous but with a tawny villosity at the base, colored like but a little paler than the pileus.

Pileus 4 to 6 lines broad; stem about 1 inch long.

Under *Abies subalpina.* Olympia mountain, Washington. "Appearing soon after the snow disappears." *L. F. Henderson.*

The species belongs to the section Calodontes, and is distinguished from *M. strobilina* by its obtuse pileus and the colored villosity at the base of the stem.

Clavaria Herveyi *n. sp.*

Gregarious or subcæspitose, simple or with a few branches, often compressed or irregular, scarcely one inch high, golden-yellow, sometimes brownish at the apex, flesh white, branches when present short, simple or terminating in few or many more or less acute denticles; spores globose, .0003 in. broad, minutely roughened; mycelium white.

Ground under hemlock trees. Orono, Maine. September. *F. L. Hervey.*

Allied to *C. fastigiata* and *C. muscoides* but distinct from both by its more irregular and less branching character and by its larger spores.

Exobasidium Cassiopes *n. sp.*

Attacking the young shoots and all their leaves, thickening and enlarging them; spores oblong, .0005 in. long.

On *Cassiope Mertensiana.* Olympia, Washington. *Henderson.*

The galls are very variable in color, and may be either pinkish, red, purple or whitish purple.

Nidularia candida *n. sp.*

Peridium externally tomentose, white, becoming cup-shaped, within glabrous, snowy-white, the mouth wide, entire; peridiola numerous, .035 to .05 in. broad, lenticular, brown, marked with numerous diverging and intercrossing blackish lines; spores broadly elliptical, .0003 in. long, .0002 broad.

Ground among mosses. Olympia, Washington. July. *Henderson.*

All the peridia seen were fully open, and therefore their shape and character when young remain unknown. The size and shape of the native plant are similar to those of *Crucibulum vulgare.* The peridiola are smaller than in that species and of a darker color. The absence of the funiculus places the species in the genus Nidularia.

Septoria Peraphylli *n. sp.*

Spots rather large, 2 to 4 lines broad, one or two on a leaf, suborbicular, reddish brown, sometimes with a whitish center above; perithecia epiphyllous, slightly prominent, black, shining; spores subcylindrical, straight or somewhat curved, or subflexuous and slightly unequal, few or many-nucleate, sometimes obscurely uniseptate, colorless or slightly colored, .001 to .0016 in. long, .00025 to .0003 broad.

Living leaves of *Peraphyllum ramosissimum.* Southern Utah. June. *M. E. Jones.*

This is an aberrant species with the spores unusually broad and variable and the perithecia rather large and somewhat unequal.

Septosporium Equiseti *n. sp.*

Hyphæ forming minute tufts, the fertile very short, bearing acrogenous spores, the sterile longer, septate, colored; spores elliptical, usually with three transverse septa and one or two longitudinal ones, colored, .001 in. long, .0005 broad.

Dead tips of branches of *Equisetum arvense.* West Virginia. June. *C. F. Millspaugh.*

Uromyces deciduus *n. sp.*

Spots none; sori minute, rotund, pulverulent, hypophyllous or amphigenous, often surrounding the young branches and occupying the whole lower surface of the leaflets, less abundant on the upper surface, rusty-brown; teleutospores oblong-illiptical or oblong-pyriform, .0008 to .0012 in. long, .0005 to .0006 broad, with the epispore roughened or verruculose, quickly deciduous from the short pedicel, a few abruptly clavate or capitate paraphyses intermingled with the teleutospores, .0012 to .0016 in. long.

Living leaflets and young branches of the screw bean, *Prosopis pubescens.* Mescal mountains, Arizona. May. *Jones.*

This species is easily known by its quickly deciduous spores and the intermingled capitate paraphyses. The pedicels are from one-fourth to one-half the length of the spores. "The fungus does not kill the leaves but causes the stem to form fascicles or bird's-nest clusters of branchlets near the end of the present year's growth."

(D.)

REMARKS AND OBSERVATIONS.

Corydalis flavula *D. C.*

In the Manual, Pennsylvania is given as the northeastern limit in the range of this species. It has been collected in New York, in Ulster county by the late W. H. Leggett, and in Onondaga county by Prof. L. E. Underwood.

Nasturtium lacustre *Gr.*

A terrestrial form of this plant occurs along the inlet of Owasco lake. The leaves are early and easily deciduous.

Hudsonia tomentosa *Nutt.*

Sandy shore of Lake Pleasant, Hamilton county.

The plants in this remarkably inland station differ so much from the typical form of the species that I am disposed to consider them a good variety. They are intermediate between *H. tomentosa* and *H. ericoides* and may therefore bear the name

Var. *intermedia.* Stems and branches more slender and longer; leaves narrow, less imbricating and less tomentose; flowers on pedicels mostly a little longer than the leaves.

The variation in the leaves, downy tomentum and pedicels is in every case toward *H. ericoides.*

Viola blanda *Willd.* var. renifolia *Gr.*

Mossy ground in woods. Helderberg mountains.

Viola cucullata *Ait.*

A form with variegated flowers. Gouverneur. *Mrs. E. C. Anthony.*

Lychnis Flos-cuculi *L.*

Grassy yard. Newark. *E. L. Hankenson.*

The specimens are unusually small and few-flowered.

Lathyrus ochroleucus *Hook.*

Common about Carrollton. June.

Fragaria Indica *L.*

Banks of Onondaga creek. *Mrs. L. L. Goodrich.*

The specimens sent by Mrs. Goodrich appear to be dwarfed. They are very much smaller than those from Staten Island. The fruit is borne singly in the axils of the leaves of the runners. The seeds are superficial on the receptacle as in *F. vesca* and in our specimens are bright red, thus giving a beautiful appearance to an insipid fruit. The petals are yellow. The plant has been introduced and probably has escaped from cultivation.

Cicuta bulbifera *L.*

In our State this plant usually blossoms and fruits very sparingly. Generally but a single umbel of flowers is developed and that terminates the main stem. Sometimes the two uppermost branches, which usually overtop the stem, are also terminated each by an umbel of flowers. Rarely very thrifty plants are still better furnished with flowers. The branches are generally well furnished with bulblets. The more the flowers the fewer the bulblets.

Solidago uliginosa *Nutt.*

Lake Pleasant. August.

This is a peculiar form in which the panicle is small, dense, oblong or thyrsiform and mostly somewhat recurved.

Aster undulatus *L.*

A very noticeable form of this species is found in dry sandy soil at Karner and also on Long Island. The leaves are thick, scabrous above, wavy on the margin, broadly or narrowly ovate, dark colored and all, except three or four near the base of the stem, are sessile by a heart-shaped base. The branches are clothed by ovate or oblong-ovate abruptly pointed bracts and bear the flowers mostly near the end either singly or somewhat clustered.

It might easily be thought to be a hybrid between *Aster undulatus* and *A. patens* which is generally associated with it or found near it, though this species flowers earlier than *A. undulatus.*

Aster cordifolius *L.* var. **lævigatus** *Porter.*

Woods and open places. Lake Mohonk, Ulster county. September.

This variety of the heart-leaved aster was discovered by Professor Porter in Pennsylvania. It also occurs in New Jersey, where Professor Britton says, it is quite as abundant as the species itself. It has also been reported from Staten Island and Westchester county in this State, but has not before been found so far north as Lake Mohonk. It is a variety strongly marked by the wing-margined petioles, the longer smooth leaves with pale under surface and more blunt and oppressed serratures. The flower-heads are generally less numerous and larger than in the type. Professor Porter remarks that perhaps it is a good species, and also that it is suggestive of a hybrid between *Aster cordifolius* and *A. lævis.*

Aster vimineus *Lam.*

This species and *A. diffusus* are not easily separated in some of their forms. Near Wells, Hamilton county, an Aster is common which has the narrow leaves of *A. vimineus*, but the hairy stem of *A. diffusus.*

Aster Novi-Belgii *L.*

A form was collected at Northville in which the heads are unusually small, being about three lines long. They are about the size of the heads of *A. dumosus.*

At Lake Pleasant, a small form occurs in which the stem is one to two feet high, rarely branched and bearing from one to six flowers of usual size. At Wells is a form like this in all respects except that the stem and midvein of the leaves are hairy as in *A. puniceus*, to which, on this account the specimens have been referred, although the leaves are much more narrow than in ordinary forms of *A. puniceus.* It may be a question whether these should be considered as a narrow-leaved, few-flowered form of *A. puniceus*, or a hairy-stemmed few-flowered form of *A. Novi-Belgii.* Both forms are apparently due to poor soil.

A form was collected near Wells, having the long linear leaves of variety *elodes.* They are four to four and a half inches long and not more than three lines wide.

Erigeron strigosus *Muhl*, var. **discoideus** *Robbins.*

Roadsides and pastures. Alcove. *C. L. Shear.* Menands and Grafton. June and July.

This variety appears, at first sight, as if its rays had been closely eaten by insects.

Lactuca leucophæa *Gr.* var. **integrifolia** *Gr.*

Along the railroad near Carrolton. September. Probably introduced from the west.

Polygonella articulata *Meisn.*

The plant is abundant in the sandy region between Albany and Schenectady. Its flowers are generally described as rose-colored or flesh-colored. They are sometimes white. Nearly all the plants in the region mentioned had white flowers the present season though in former seasons they have been generally rose-colored. What made the difference?

Populus balsamifera *L.*

Not rare in the Adirondack region. Near Elizabethtown, Essex county, are trees which appear to connect the species and the variety *candicans.* The leaves on the older branches are truncate or subcordate, but those on the young and thrifty branches and shoots from the roots are somewhat pointed at the base as in the type. The hairiness of the petiole is scarcely perceptible.

Clintonia umbellata *Torr.*

Fine flowering specimens were found near Carrollton. The leaves and scape are generally more or less pubescent. The umbel consists of six to eighteen small white flowers in a close erect cluster. Usually there is a bract just below the umbel. It grows in damp places either in pastures or in woods, and is in flower in June.

Erythronium Americanum *Ker.*

The bulbs of this plant sometimes emit long white leafless runners or offsets which come to the surface and after describing an irregular curve a few inches long, thrust the growing tip beneath the surface again. One bulb, dug from beneath the decaying leaves, had a leaf at one end and two offsets growing from the other.

Cyperus dentatus *Torr.*

Abundant on the sandy shore of Lake Pleasant. The spikes are changed to leafy tufts in almost every plant in this locality.

Eleocharis tuberculsosa *R. Br.*

Erastina, Richmond county. November. *N. L. Britton.*

Scirpus sylvaticus *L.* var. digynus *Bœckl.*

This sedge is apparently more common than has been supposed. Fine specimens were obtained near Wilton, Saratoga county. It maintains its distinguishing characters with great uniformity and is apparently a good and distinct species, easily recognizable at a glance and at once distinguishable from *S. sylvaticus* by its more densely clustered darker colored spikelets and by the purplish red sheaths that give a variegated appearance to the stem.

Scirpus polyphyllus *Vahl.* var. macrostachyus *Bœckl.*

Lake Pleasant. August. This variety is not indicated in the Manual. It differs from the ordinary form of the species as represented in our flora, in being less leafy, in having much longer and darker colored spikelets, shorter achenes and longer, more slender and more sparsely and irregular barbed bristles. In general appearance it is quite unlike the leafy form with short-ovate, densely clustered yellow-brown spikelets. Occasionally a slender pedical supporting a cluster of spikelets rises from the axil of the uppermost leaf.

Eriophorum cyperinum *L.* var. laxum *W. & C.*

This variety was found at Lake Pleasant growing, in several instances, side by side with the typical form of the species. In addition to the distinguishing characters mentioned in the Manual it was found that when growing side by side and, so far as could be seen, subjected to exactly the same conditions, the variety reached maturity much earlier than the type. The woolly bristles of the mature plant are much paler and less dense in the mass. Sometimes the spikelets are all contracted into a single dense cluster one to two inches in diameter.

Carex flava *L.* var. graminis *Bailey.*

Borders of lakes. Adirondack mountains. July. In our specimens the perigynia often have the beak deflexed as in the type, but in other respects the agreement with the description is good.

Carex granularis *Muhl.* var. Haleana *Porter.*

Swamp near Meadowdale. June.

Carex alopecoidea *Tuckm.*

Plentiful about Lyons, Wayne county. June.

Muhlenbergia sylvatica *T. & G.*

A form with branches erect and with purplish densely flowered panicles occurs about Lake Pleasant and also at Wells.

Muhlenbergia sobolifera *Trin.*

This species is common enough in the lower part of the valley of the Hudson and on the Shawangunk mountains, but I have not observed it north of Saugerties.

Agrostis vulgaris *With.*

This grass grows freely in sandy soil. A very stout, rigid form with dark purple panicles was found growing in the loose sharp sand along the shore of Lake Pleasant.

Poa compressa *L.* var. **sylvestris** *Torr.*

This variety grows in open places as well as in woods. Fine specimens were found at Menands. It is easily recognized by its short open or spreading panicle.

Asplenium montanum *Willd.*

This fern was discovered to be an inhabitant of our State about twenty years ago. It was then found growing from crevices in the rocks about Lake Mohonk. This has remained its only known station in our State until the present season, in which I learn it has been found in the Catskill mountains, a station still farther to the north. Mr. Smiley informs me that it has been found in several new places about Lake Mohonk, that it appears to be increasing in abundance and that it is in no danger of extermination there, for it grows on the faces of the cliffs in places where it is wholly inaccessible to the most eager collector.

Collybia radicata *Relh.* var. **furfuracea** *n. var.*

Pileus and lamellæ as in the typical form; stem more slender, generally slightly tapering upward, *even*, *fufruraceus*, more or less brownish.

This form is much more common with us than the type. The variation is toward *C. longipes*, which has the stem villose rather than furfuraceous, and its pileus is dry and velvety, but in our plant it is glabrous and viscid or glutinous when moist. As in the type, the pileus is sometimes umbonate. There is a dwarf form which is quite common. In it the pileus is from six to sixteen lines broad and the stem proportionably slender. It might be designated as var. *pusilla*.

(E.)

NEW YORK SPECIES OF OMPHALIA.

Omphalia *Fr.*

Pileus thin, submembranaceous. Lamellæ decurrent. Stem cartilaginous, stuffed or hollow, somewhat thickened upwards. Spores white.

The species of Omphalia are generally small, the pileus rarely exceeding an inch or an inch and a half in diameter. It is usually umbilicate, a character which gives name to the genus, the word Omphalia being derived from the Greek, ὸμψαλος an umbilicus. It is sometimes either umbilicate or umbonate even in the same species. It is generally very thin, almost or quite membranous, and most often hygrophanous, so that generally it is striate or striatulate when moist. When mature, it assumes a funnel shape in a few species and then simulates some species of Clitocybe, but from these the species of Omphalia may be distinguished by their cartilaginous stem. From species of Mycena they are separated by their truly decurrent lamellæ.

They grow chiefly on decaying wood or other vegetable matter or on soil largely composed of such matter. They are fond of moisture and are to be sought in damp shaded places or in wet weather. Some occur in cold situations or at high altitudes, and others appear to be capable of enduring great variations in temperature. *O. Campanella*, one of our most common and most abundant species may be found throughout the season. It may even be found in sheltered cavities or on the under side of decayed prostrate trunks when the ground is covered with snow. On the other hand many species are quite rare, and some here described have been found but once in many years of exploration. Because of their small size the species are not regarded as important for the table and none are classed as edible.

The grouping of the species in the Friesian arrangement depends upon the primary form of the pileus, the character of its margin and the degree of proximity of the lamellæ to each other, but these characters have not appeared to me to be very sharp and satisfactory and in the following pages I have disregarded them.

O. subgrisea has been found to belong to another genus, and *O. tubæformis* is probably a large form of *Marasmius salignus.*

SYNOPSIS OF THE SPECIES.

	Lamellæ white, whitish or grayish	1
	Lamellæ some other color	14
1.	Plant wholly white	2
1.	Plant not wholly white	5
2.	Pileus viscid when moist	3
2.	Pileus not viscid	4
3.	Stem adorned with minute gland-like protuberances,	O. Rhododendri.
3.	Stem without protuberances	O. Austini.
4.	Pileus somewhat funnel-form	O. scyphoides.
4.	Pileus convex	O. stellata.
4.	Pileus hemispherical	O. gracillima.
5.	Pileus yellowish or orange	6
5.	Pileus some other color	8
6.	Lamellæ arcuate	7
6.	Lamellæ subtriangular	O. umbellifera.
7.	Pileus 6 lines or more broad	O. fibuloides.
7.	Pileus less than 6 lines broad	O. Fibula.
8.	Pileus with the umbilicus darker	9
8.	Pileus uniformly colored	10
9.	Pileus 6 lines or more broad	O. Oculus.
9.	Pileus 2 to 4 lines broad	O. Swartzii.
10.	Pileus dotted with blackish points	O. Gerardiana.
10.	Pileus without blackish points	11
11.	Lamellæ uniformly colored	12
11.	Lamellæ with the edge darker	O. montana.
12.	Pileus less than 6 lines broad	O. corticola.
12.	Pileus more than 6 lines broad	13
13.	Pileus rugose on the disk	O. rugosidisca.
13.	Pileus even on the disk, glabrous	O. striipilea.
13.	Pileus silky or flocculose	O. Epichysium.
14.	Pileus viscid	O. lilacifolia.
14.	Pileus not viscid	15
15.	Pileus olive green	O. olivaria.
15.	Pileus some other color	16
16.	Stem bright yellow	O. chrysophylla.
16.	Stem pallid or rufescent	O. pyxidata.
16.	Stem date-brown	O. Campanella.

Omphalia rugosidisca *Pk.*

RUGOSE-DISKED OMPHALIA.

(Report 26, p. 55.)

Pileus thin, broadly convex or nearly plane, umbilicate obtuse or slightly umbonate, sometimes slightly umbilicate, *rugose on the disk*, glabrous, hygrophanous, brown and striatulate when moist, paler when dry, the thin margin often wavy; lamellæ narrow, close, arcuate, decurrent, white, *emitting drops of a watery juice where cut or broken;* stem short, glabrous, hollow, often curved, whitish or colored like the pileus; spores elliptical, .00025 to .00028 in. long, .00016 broad.

Pileus 6 to 12 lines broad; stem about 1 inch long, .5 to 1 line thick.

Decaying prostrate trunks of coniferous trees, especially hemlock. Adirondack mountains, Otsego, Ulster, Albany and Rensselaer counties. July to September.

The species is remarkable because of the watery juice which oozes in drops from the lamellæ of the fresh plant where cut or broken.

Omphalia lilacifolia *Pk.*

LILAC-LEAVED OMPHALIA.

(*Agaricus lilacinus* Rep. 24, p. 63. *A. lilacifolius* Rep. 29, p. 66.)

Pileus convex, deeply umbilicate, glabrous, *viscid*, hygrophanous, dingy-yellow with a slight greenish tinge and striatulate when moist, bright sulphur-yellow when dry; lamellæ close, narrow, arcuate, decurrent, *pale lilac;* stem equal, glabrous, hollow, *viscid*, yellowish with a *pale lilac-colored mycelium at the base;* spores subelliptical, .0002 to .00025 in. long, about .00012 broad.

Pileus 6 to 12 lines broad; stem 6 to 12 lines long, .5 to 1 line thick.

Decaying prostrate trunks of hemlock. Oneida and Albany counties. September.

This is a very distinct species, remarkable for its viscid pileus and stem and for the peculiar hue of the lamellæ and mycelium.

Omphalia Oculus *Pk.*

EYE-SPOT OMPHALIA.

(Report 23, p. 84.)

Pileus convex, umbilicate, often with a small umbo or papilla in the umbilicus, *minutely squamulose*, dingy-white, *the umbilicus blackish-brown;* lamellæ white, narrow, close, subarcuate; stem hollow, minutely squamulose or furfuraceous, easily splitting, often curved, whitish; spores subglobose, .00016 to .0002 in. in diameter.

Pileus 6 to 12 lines broad; stem 1 to 1.5 in. long, 1 to 2 lines thick.

Prostrate trunks of hemlock in woods. Adirondack mountains. August.

The dark colored umbilicus is a noticeable feature. The plant has not been found since its discovery in 1869. The species is evidently rare. It is apparently closely related to *Collybia abundans*, from which it is distinguished by its more decided darker umbilicus and squamulose pileus.

Omphalia olivaria *Pk.*

OLIVE-GREEN OMPHALIA.

(Report 25, p. 76.)

Pileus convex, umbilicate, glabrous, *olive-green;* lamellæ subdistant, arcuate-decurrent, *pale-yellow;* stem equal, short, glabrous, hollow, colored like the pileus; spores subglobose or broadly elliptical, .00025 to .00028 in. long, about .0002 in. broad.

Pileus about 1 in. broad; stem about 1 in. long, 1 line thick.

Burnt ground under balsam fir trees. North Elba, Essex county. July.

This plant was discovered in 1871. It has not since been found.

Omphalia chrysophylla *Fr.*

GOLDEN-LEAVED OMPHALIA.

(Hym. Europ. p. 156. Syl. Fung. Vol. V, p. 312.)

Pileus convex or nearly plane, flocculose, umbilicate, hygrophanous, yellowish-brown when moist, paler when dry, the spreading margin sometimes reflexed; lamellæ broad, distinct, distant, strongly decurrent, *bright-yellow;* stem equal, tough, hollow, sometimes curved, even, glabrous, villous at the base, *yellow;* spores oblong-elliptical, .0004 to .00045 in. long, .00016 to .0002 broad.

Pileus about 1 in broad; stem 1 to 1.5 in. long, 1 to 2 lines thick.

Decaying wood of coniferous trees. Adirondack mountains, Schoharie and Rensselaer counties. August and September.

Var. *chrysea*. (Agaricus chryseus, Rep. 23, p. 85.)

Whole plant yellow, lamellæ rather narrow.

This differs from the true *O. chrysophylla* so slightly that it seems best to regard it as a mere variety of that species. The pileus varies in depth of coloring and the spores in the American plant, from which the dimensions here given were taken, are somewhat longer than the dimensions ascribed to those of the European plant. This fungus is not common.

Omphalia pyxidata *Bull.*

CUP-SHAPED OMPHALIA.

(Hym. Europ. p. 157. Syl. Fung. Vol. V, p. 318.)

Pileus at first convex or nearly plane and umbilicate, then funnel-form, glabrous, hygrophanous, brick-red or reddish-brown when moist and wholly radiate-striate, or on the margin only, pale when dry and flocculose or slightly silky; lamellæ narrow, subdistant, decurrent, tinged with flesh-color, then *yellowish;* stem equal, tough, glabrous, stuffed or hollow, *pallid or reddish;* spores subelliptical, .00025 to .0003 in. long, .00015 to 0002 broad.

Pileus 6 to 12 lines broad; stem about 1 in. long, 1 line thick.

Grassy or mossy ground in pastures. Lewis county. September.

This is evidently a rare species with us, as it has not been observed since its discovery here in 1870.

Omphalia striipilea *Fr.*

STRIATE-CAPPED OMPHALIA.

(Hym. Europ. p. 157. Syl. Fung, vol. V, p. 314)

Pileus membranous, convex or plane, umbilicate, never funnel-form, *glabrous*, hygrophanous, livid brown and beautifully *striate when moist*, even and paler when dry; lamellæ not crowded, slightly decurrent, whitish; stem equal, rather firm and tough, glabrous, hollow, often flexuous, *brownish;* spores nearly or quite globose, .00025 to .00028 in. broad.

Pileus 6 to 12 lines broad; stem 1 to 1.5 in. long, about 1 line broad.

In groves of spruce and balsam fir. Essex county. September.

Omphalia Epichysium *Pers.*

OVERSPREADING OMPHALIA.

(Hym. Europ. p. 158. Syl. Fung. vol. V, p. 314)

Pileus membranous, soft, nearly plane, umbilicate, hygrophanous, sooty-gray and striate when moist, paler when dry and *silky or flocculose;* lamellæ narrow, subdistant, slightly decurrent, whitish or cinereous; stem equal, somewhat hollow, glabrous, cinereous; spores elliptical, .0003 in. long, .00016 broad.

Pileus 6 to 12 lines broad; stem about 1 inch long, 1 line thick.

Decaying wood and dead trunks of trees. Adirondack mountains. August.

Omphalia Gerardiana *Pk.*

GERARD'S OMPHALIA.

(Agaricus Gerardianus. Rep. 26, p. 54)

Pileus thin, nearly plane or soon funnel-form, generally umbilicate, fragile, *dotted with minute blackish points*, hygrophanous, brown or grayish-brown and striatulate when moist, paler when dry; lamellæ narrow, subdistant, decurrent, sometimes forked, whitish or cinereous; stem long or short, glabrous, stuffed or hollow, colored like the pileus; spores oblong or ovate-oblong, .0003 to .00045 in. long, about .00016 broad.

Pileus 8 to 12 lines broad; stem 1 to 2.5 in. long, .5 to 1 line thick.

Growing in Sphagnum. Rensselaer, Ulster and Seneca counties. June.

This fungus was formerly referred to the subgenus Clitocybe, but later observations indicate a closer relationship to Omphalia. It is closely related to such species of Omphalia as *O. affricata*, *O. telmaticæa*, *O. sphagnicola* and *O. philonotis.* From all these it differs in the peculiar adornment of the pileus.

Omphalia montana *Pk.*

MOUNTAIN OMPHALIA.

(Report 27, p. 94.)

Pileus thin, umbilicate, glabrous, blackish-brown; lamellæ distant, decurrent, whitish, *darker on the edge*, stem equal, glabrous, colored like the pileus; spores broadly elliptical, about .0003 in. long.

Pileus 6 to 8 lines broad; stem about 1 inch long, 1 line thick.

Thin soil covering rocks. Mount Marcy. August. Very rare. Not found since 1873. Remarkable for the discolored edge of the lamellæ.

Omphalia umbellifera *L.*

UMBEL-BEARING OMPHALIA.

(Hym. Europ. p. 161. Syl. Fung. vol. V, p. 321.)

Pileus convex or plane, somewhat obconic, hygrophanous, radiate-striate when moist, whitish or pale-yellow; lamellæ *broad, distant, somewhat triangular*, white; stem short, stuffed, becoming hollow; spores broadly elliptical, .0003 to .0004 in. long, .0002 to .00025 broad.

Pileus 4 to 8 lines broad; stem 6 to 10 lines long, .5 line thick, ground or decaying wood.

Var. *scabriuscula.* (*Agaricus scabriusculus* Rep. 23, p. 85.)

Plant commonly larger, pileus flocculose-pulverulent, yellow; lamellæ white or pale-yellow, the interspaces venose; stem hairy-squamulose.

Decaying wood. Adirondack mountains.

This is a very variable species. It occurs from June to September, and grows on ground largely composed of decomposed vegetable matter or on much decayed wood. In this State it seems to be limited in its range to the Adirondack region and there it ascends to the tops of the highest peaks. Its pileus and broad lamellæ together have an obconic shape. It is often irregular or misshapen. The stem may be either glabrous, pruinose or hairy-squamulose. Sometimes it is pubescent or villose at the base only. The pileus is either glabrous or silky or flocculose-pulverulent.

Omphalia Campanella *Batsch.*

BELL-SHAPED OMPHALIA.

(Hym. Europ. p. 162. Syl. Fung. vol. V, p. 327.)

Pileus thin, rather tough, hemispherical or convex, glabrous, umbilicate, hygrophanous, yellow-ferruginous and striatulate when moist, paler when dry; lamellæ moderately close, arcuate, decurrent, yellowish, the interspaces venose; stem firm, rigid, hollow, *brown*, often paler at the top, *tawny-strigose at the base;*

spores elliptical, .00024 to .00028 in. long, .00012 to .00016 broad. Pileus 4 to 8 lines broad; stem about 1 in. long, scarcely 1 line thick.

Much decayed wood of coniferous trees. Very common. May to November.

This pretty little species occurs everywhere in woods and shaded places where there are prostrate, much decayed trunks of hemlock, spruce and pine. It makes its appearance as soon as the weather is moderately warm in spring, and successive crops develop till all growth is stopped by the return of the cold weather of winter. Rarely it grows on ground well filled with decaying vegetable matter. It usually grows in large flocks or dense clusters but sometimes is more scattered. It is the most frequent and most abundant of our species of Omphalia and is easily recognized by its yellowish-red pileus, dark-brown stem and the little ball or tuft of tawny-colored coarse hairs at the base of the stem. The pileus varies some in the intensity of its color but all the hues of the moist plant appear to be mixtures of yellow and dull red in different proportions. In the dry plant, the yellow predominates. The mycelium of this species is regarded as destructive to the wood of coniferous trees.

Omphalia fibuloides *Pk.*

BUTTON-LIKE OMPHALIA.

(Report 24, p. 63.)

Pileus thin, convex, deeply umblicate, glabrous, hygrophanous, dull orange and striatulate when moist, paler when dry; lamellæ *rather close*, arcuate strongly decurrent, white, the *interspaces venose;* stem equal, glabrous, hollow, colored nearly like the pileus; spores *elliptical*, .0003 in. long, .0002 broad.

Pileus 6 to 10 lines broad; stem 1 to 2 in. long, scarcely 1 line thick.

Burnt, mossy ground. Lewis and Sullivan counties. September.

It is closely related to *Omphalia Fibula*, which it resembles in color, but from which it may easily be distinguished by its much larger size, more robust habit and venose interspaces. Its spores also are larger than in that species.

Omphalia Fibula *Bull.*

BUTTON OMPHALIA.

(Hym. Europ. p. 164. Syl. Fung. vol. V, p. 331.)

Pileus membranous, commonly convex or hemispherical and umbilicate, striatulate when moist and varying in color from pale-yellow to orange, even and paler when dry; lamellæ *distant*, arcuate, strongly decurrent, white; stem slender, commonly long in proportion to the breadth of the pileus, colored like or a little paler than the pileus; spores *narrowly elliptical*, minute, .00016 in. long, .0008 broad.

Pileus 2 to 5 lines broad; stem 1 to 2 in. long, scarcely .5 line thick.

Mossy ground and prostrate mossy trunks of trees in woods or open places. Common. April to November.

Var. *conica*. Pileus conical, not umbilicate, sometimes papillate. Fulton county.

This is a very small species and of frequent occurrence in damp mossy places, but rarely abundant. Its pileus varies in color from almost white to bright orange. Large forms approach the preceding species in appearance.

Omphalia Swartzii.

Agaricus Fibula var. *Swartzii* Fr.

SWARTZ'S OMPHALIA.

(Hym. Europ. p. 164. Syl. Fung. vol. V, p. 331.)

Pileus rather firm, even, whitish, *disk brownish;* stem whitish, somewhat *violaceous at the top*. In other respects like the preceding species.

Although this plant scarcely differs from *O. Fibula* except in color, and is regarded by almost all mycologists as a mere variety of it, yet it is so peculiar and so constant in its color and so easily recognized that it seems best to separate it as a species.

Omphalia corticola *Pk.*

BARK-INHABITING OMPHALIA.

(Report 44, p. 18)

Pileus submembranous, convex, then expanded and umbilicate, distantly radiate-striate, *whitish or pale-cinereous;* lamellæ narrow, distant, *at first arcuate and adnate*, then truly decurrent, white;

stem short, curved, subpruinose or sprinkled with mealy particles, at first whitish with a brown base, then brown with a whitish top; spores elliptical, .0003 in. long, .00016 broad, generally containing a single large nucleus.

Pileus 2 to 4 lines broad; stem 4 to 6 lines long.

Bark of oak trees. Cattaraugus county. September.

This species is distinguished from *Mycena corticola* by its paler pileus, more narrow and, at length, decurrent lamellæ and elliptical spores.

Omphalia gracillima *Weim.*

SLENDER OMPHALIA.

(Hym. Europ. p. 165. Syl. Fung. vol. V, p. 332.)

Pileus membranaceous, *hemispherical*, papillate or umbilicate, somewhat flocculose when young, becoming glabrous, sulcate on the margin, white; lamellæ thin, somewhat distant, decurrent, the alternate ones shorter, white; stem filiform, white, inserted by a floccose base; spores elliptical, .00024 in. long .0001 broad.

Pileus 2 to 3 lines broad; stem 4 to 8 lines long.

Dead twigs and fallen leaves in wet places. Rensselaer county. September.

A very small delicate species, the whole plant pure white.

Omphalia stellata *Fr.*

STELLATE OMPHALIA.

(Hym. Europ. p. 162. Syl. Fung. vol. V, p. 325.)

Pileus membranous, *convex*, *umbilicate*, glabrous, striate, diaphanous, white; lamellæ broad, very distant, thin, decurrent, white; stem filiform, fragile, equal, glabrous, white, radiate-floccose at the base; spores subglobose or broadly elliptical, .00024 in. long, .0002 broad.

Pileus 2 to 4 lines broad; stem 6 to 10 lines long.

Decaying prostrate trunks of trees in woods. Albany county. August.

Omphalia Rhododendri *Pk.*

RHODODENDRON OMPHALIA.

(Report 27, p. 94.)

Pileus convex, umbilicate, glabrous, slightly viscid when moist, striate on the margin, white; lamellæ subdistant, arcuate, decurrent, white, beaded on the edge with gland-like protuberances; stem slender, *roughened with minute white gland-like protuberances*, white; spores oblong or narrowly elliptical, .0003 in. long, .00012 broad.

Pileus 2 to 3 lines broad; stem 6 to 8 lines long.

Dead stems of great laurel, *Rhododendron maximum.* Sullivan county. September.

Omphalia Austini *Pk.*

AUSTIN'S OMPHALIA.

(Report 28, p. 48.)

Pileus rather tenacious, convex or hemispherical, glabrous, striate, deeply umblicate, sometimes perforate, *vicid when moist*, white; lamellæ subarcuate, distant, decurrent, white; stem equal, hollow, *even*, glabrous, villose at the base, white; spores elliptical, .0003 in. long, .0002 broad.

Pileus 3 to 6 lines broad; stem 1 to 1.5 in. long, .5 line thick.

Decaying wood of spruce. Saratoga, Hamilton, Fulton and Essex counties. July and August.

Rarely the pileus has a slight smoky or grayish tint.

Omphalia scyphoides *Fr.*

CUP-LIKE OMPHALIA.

(Hym. Europ. p. 156. Syl. Fung. vol. V, p. 310.)

Pileus submembranous, plane and umbilicate or funnel-form, often irregular or somewhat eccentric, even, silky, white; lamellæ *narrow*, *close*, decurrent, white; stem short, stuffed, subvillose, white; spores elliptical, .00024 inches long, .00016 to .0002 broad.

Pileus 2 to 4 lines broad; stem 4 to 8 lines long.

Decaying wood, leaves, etc., Saratoga county. July and August.

In our specimens there is no villosity on the stem except at the base.

REPORT

OF THE

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FOR THE YEAR 1891.

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REPORT.

Office of the State Entomologist,
Albany, *November* 25, 1891.

To the Regents of the University of the State of New York:

Gentlemen. — I have the honor of presenting to your board my Eighth Report on the Injurious and Other Insects of the State of New York, containing the results of observations and studies made by me during the present year.

The year has not been prolific in insect life, either in the multiplication of individuals of a species, or in the number of special pests. The abundance of insects varies greatly in different years. While this may be, and often is, controlled to a large extent by the beneficent provision in nature of parasitism, through which certain classes of insects live wholly at the expense of others, it is still more largely due to meteorological conditions, varied in their nature and complex in their influences. Among these may be named drouth, excessive moisture, high temperature, severe cold, late and early frosts, depth of frost, winds, cold rains, continued rain, and absence or abundance of snow. Under such diverse and conflicting conditions, the aggregate of insect injury for any year can never be foretold for months in advance, although in individual cases, as in the chinch-bug and the western locust, predictions for the succeeding season have been made and verified. An excessive abundance of an insect pest in one year may be followed by its almost entire absence in the next, while a disastrous attack may suddenly be made upon a valuable crop by an insect long known but never before recognized as of the slightest economic importance.

When to these fluctuations in insect life there is added continually changing habits, wild food-plants deserted for cultivated ones, gradual extension of geographic range, introduction by commerce from abroad, etc., etc., it is not surprising that each year should bring to the economic entomologist new subjects for study, and in such rapid succession that hardly a tithe can be given proper investigation.

The present year, even more markedly than the preceding, has been exempt from severe insect attacks upon the grain crops of the State. These agricultural staples have been almost entirely free from the destructive midges — the wheat-midge and the Hessian-fly, that in former years have often occasioned such serious losses; and but little harm has been inflicted by the grain-aphis. The hop crop was not greatly injured by the hop-vine aphis, *Phorodon humuli*. The potato beetle has been less abundant than usual, and in most localities where mention has been made of its presence, it was so late in making its appearance that less than ordinary effort was required for keeping it within control. In some of the Hudson river counties, injuries from it were first reported in the early part of July. In portions of Cattaraugus county it is said to have been unusually abundant during the month of July.

With the large acreage devoted to fruit-growing in the State of New York, its annual extension, and the increasing care which is required in order to insure a good degree of protection from insect and fungus attack—it might naturally be expected that fruit insects should claim the foremost place among our insect foes. They have certainly taken such rank the present year, for among the hundreds of inquiries received of name, habits, remedies, etc., through personal application and a correspondence largely in excess of any former year, more than three-fourths have been of the insect depredators of orchards and of the smaller fruits. And to no inquiries have a more cordial welcome been given by your entomologist than to these, for, thanks to progress made in applied entomology, and the earnestness with which this useful science is being studied—in almost every instance there has been the ability of returning answer that could hardly fail of substantial benefit to the inquirer.

Referring to a few of these fruit insect attacks: The apple-tree tent caterpillar, *Clisiocampa Americana* Harris, which has been unusually destructive for several years past, has not been the cause of as frequent complaint as in the preceding year. This may have resulted from the more general care that has been given to the collecting and burning of the eggs during the winter, and to destroying the nests or tents of the young caterpillars when they are first to be seen in the forks of the branches. Reports of the abundance of this caterpillar have been received from Westchester, Dutchess, Chemung, and Oswego counties.

The apple-tree aphis, *Aphis mali* Fabr., while not very generally distributed, appeared in remarkable numbers in a few localities—in Oswego, Monroe, and Essex counties, and elsewhere. The season, however, was not propitious for its increase, and the aggregate amount of injury caused by it was not large. This insect may so easily be killed by kerosene emulsion spraying—either while in the egg or at the time of its hatching, that losses from it in the orchard deserve to be charged, in the profit and loss account, to the item of carelessness.

The apple-leaf Bucculatrix, *Bucculatrix pomifoliella* Clemens, is extending its range, and is now to be found in nearly every county of the State. In Oswego, Wayne, Orleans, Monroe, Niagara, Livingston, and Ontario counties, its peculiar, white ribbed cocoons are so numerous as to readily attract the eye. Yet, little complaint has been made during the year of injury from it. Many of the cocoons seen upon the twigs are those of former years, and therefore tenantless. An effective parasitic attack has fortunately been made upon it which is largely reducing its numbers. Mr. Powell, Director of the Farmers' Institutes, reports that at a recent institute held at Sodus, Wayne county, on a small piece of apple-twig brought in, containing thirty of the cocoons, twenty-five had been destroyed by the parasite, as shown by a small hole eaten through one end of the cocoon.

Another Tineid apple-tree depredator, *Coleophora malivorella* Riley, rare to the State (see 1st Report Ins. N. Y., page 163), was received in the early spring from Oswego and Wayne counties. While not yet abundant in New York, it would not be a difficult task to prevent its becoming a serious pest.

Although of slight economic importance, yet of considerable interest from its rarity and limited extent, is the occurrence during the autumn of the apple leaf-sewer, *Phoxopteris nubeculana* (Clemens), in an orchard at Palmyra, Wayne county, N. Y. While in this orchard nearly one-half of the leaves have been neatly folded over near the midrib and the two edges fastened together to form the shelter for the hibernating larva, none of the other orchards in the vicinity show the presence of the insect.

Reference was made, and a brief notice given, in the Report for last year, to injuries to apple buds, blossoms, and leaves by the caterpillar of another Tortricid moth, *Tmetocera ocellana* (Schiff.), or the eye-spotted bud-moth — so named from an eye-like spot on its wings. The present year it has greatly multiplied in the "apple-belt" of Western New York; and its pernicious work in eating into the buds, and destroying the blossoms, and feeding on the tender foliage, has materially lessened the production of fruit in many localities. A large orchardist in Wayne county has written me that he has found it almost impossible to check, in the slightest degree, its ravages, and that it has done him more harm than all other apple pests combined. A full knowledge of its life-history, which we do not yet possess, will, it is hoped, reveal some simple and effective means by which it may be controlled.

Of the comparatively small number of insects attacking the pear, and none of which have seriously interfered with its cultivation, two insects have emerged from their obscurity during the present year, and have been the occasion of no little alarm in localities where they have abounded. Of these, the pear-tree *Psylla pyricola* Foerst.,— an aphis-like creature, has been quite destructive in orchards in Greene and Columbia counties on the Hudson river, through sucking the sap from the buds, leaves, and stems of the young fruit, and covering them and the twigs with an impervious coating of honey-dew. Later in the season a fungus develops upon this viscid excretion and blackens the twigs and terminal branches of the infested trees as if they had been painted. From an orchard in Columbia county where the crop gave promise of yielding 1,200 bushels of pears — as the result of the operations of this insect, only 400 bushels of indifferent fruit was gathered.

The other of the two is the pear-midge, *Diplosis pyrivora* Riley, which had not, hitherto, been reported in the State of New York — its only known locality in the United States being Meriden, Conn., where it is believed to have been introduced from France about fifteen years ago. The eggs of the parent midge are deposited in the blossom before they open, and the larvæ therefrom, to the number of twenty or more, burrow and feed within the young fruit wholly withdrawn from the reach of insecticidal applications. At maturity they escape from the fruit and drop to the ground, where they bury for their transformation, to reappear the following spring as the winged midge. The infested fruit, with its interior eaten away, soon falls from the tree. The insect, wherever observed—in France, England, and in this country, has shown a decided preference for some particular variety of pear, while attacking most of the others. With us, the Lawrence has been the attractive one, to the extent of its crop proving almost an entire failure — at least nine-tenths of it having been destroyed both in Meriden, Conn., and at Catskill, N. Y. Notice of both of these insects will be found in the following pages, where the results of the studies made upon them are detailed.

In my fifth report account is given of an attack on young pears at Rochester, N. Y., in which the fruit was completely ruined by the gnarling, knotting, and deformation caused by the punctures and feeding of one of the plant-bugs, *Lygus pratensis* (Linn.). A similar attack was brought to my notice during the early summer, occurring at South Byron, Genesee county, of a closely resembling species, *Lygus invitus* (Say). The operation of the insect was carefully watched, and interesting observations made upon it. Fortunately, these injuries, while quite general, are not often severe. In only one other instance were they deemed of sufficient importance to merit report — in Monroe county, where a crop of Seckels was badly gnarled in August from a second brood of the *Lygus*.

Of other fruit insects of which complaint has been made, these may be noticed: The cherry aphis, *Myzus cerasi* (Fabr.), caused considerable injury in St. Lawrence county in the early part of July. The plum aphis, *Aphis pruni* Fabr., abounded in some plum orchards at Schoharie, N. Y., affecting the foliage quite severely. The plum curculio was unusually harmful in parts of Albany county. It is rarely so injurious in the eastern part of the State that it is necessary to resort to "jarring" for its destruction. At North Salem, Westchester county, the rose-bug, in the latter part of June, is said to have almost ruined grapes and peaches, and somewhat later, vineyards in Jefferson and Oswego counties were reported as nearly destroyed by immense swarms of the same insect. According to an account received, the currant-worm, *Nematus ribesii* Scop., when threatening the destruction of the currant crop, at Millbrook, Dutchess county, early in June, was killed by heavy rains occurring at that time.

The cow-horn fly, *Hæmatobia serrata* R. Desv., which has been noticed in a former report, has made its appearance in a few, but widely separated, localities in the State, and its speedy general distribution may therefore be looked for, unless the measures recommended for the prevention of its increase shall be generally adopted.

A new onion pest attacked the onion crop at Canastota, in Central New York, during the month of June. It was a dark-colored caterpillar of over an inch in length, which fed on the plants above ground, and overran the large fields of onions in the muck lands about Canastota, feeding also on weeds and other vegetation. It was at first thought to be the same cut-worm that in the year 1885 was so exceedingly destructive in the extensive onion fields in Goshen and vicinity in Orange county. But its critical examination indicated it to be a different species, viz., *Agrotis ypsilon* (Rott.), and the subsequent rearing of the moth proved it to be that common insect, which had not been recognized before as an onion feeder.

From Chenango county an estimate was received of twenty per cent injury to corn from cut-worms — the species not identified.

Epilachna borealis (Fabr.), the northern lady-bug — quite exceptional in its family for its injurious habits, has again been destructive this year in its extraordinary numbers, to melon and squash vines upon Long Island.

Most of the above, together with others not here referred to, are noticed in the body of the report.

It gives me pleasure to report an increasing interest each year shown by the people of the State in the work of this Department. This is particularly marked on the part of the agricultural community, who are thoroughly awakened to the importance of protecting their crops from the steadily increasing hosts of their insect enemies. So frequent are the requests from farmers and fruit-growers for information and for aid, that almost my entire time during the year has been occupied in the study of these successive attacks, and of the best methods for their control. While service rendered in this direction is beyond question quite as valuable as any other that may be given, still it is necessary that a certain amount of purely scientific work should accompany economic studies, if their published results are to be accepted as valuable scientific contributions.

The collections made during the year were not as large as in some preceding years, owing to the shorter time that could be spared from office duties, and from a lesser abundance than usual of insect life. Particular attention was again given to the insects occurring in high altitudes in the Adirondack region, the fauna of which has been so imperfectly explored. Several new and many valuable forms were obtained in Essex county, in the towns of North Elba, Wilmington, and Keene, and life-histories, more or less complete, worked out.

Contributions to the collections have been received from a larger number of donors, but aggregating less in the number of specimens than reported in 1890. As of special value may be particularized a package of alcoholic specimens of Lepidoptera from Mr. H. G. Dyar, of New York city, mainly of rare larval forms, collected by him in the Yosemite valley, Cal., and described in scientific journals.

The report herewith submitted contains, under the division of INJURIOUS INSECTS, a somewhat full notice of the several species, after the manner in which I would be glad to present most of the insects embraced in these reports, i. e., in so general and full an account, drawn from their literature and combined with new observations as may afford ample means for the arrest of their depredations, or their protection if desirable. But this, under the requirement for the completion of the report in readiness for printing on the first of October, is impracticable. I have, therefore, embodied under NOTES ON VARIOUS INSECTS, such briefer notices as seemed worthy of placing on record at the present time; and under INSECT ATTACKS: THEIR REMEDIES AND PREVENTIVES, notices of several of the more interesting attacks of the year, together with approved remedies for some of the long and well known insect pests.

The Appendix contains two addresses made before State boards of agriculture by the Entomologist, and a list of the principal publications of the Entomologist during the year, of which fifty-seven are named and brief summaries given; also the usual list of the contributions to the collections of the department.

The additional room and cases for which arrangements are being made by your board for the use of the Entomologist, will remove the discomfort and hindrance of an overcrowded office, and permit of a more convenient and systematic arrangement of the library and the collections.

With grateful acknowledgment of aid and courtesies extended.

Respectfully submitted.

J. A. LINTNER.

INJURIOUS INSECTS.

Synchlora glaucaria (Guenée).

The Raspberry Geometer.

(Ord. LEPIDOPTERA: Fam. GEOMETRIDÆ.)

Aplodes glaucaria GUENÉE: Hist. Nat. Ins.–Lepidop., ix, 1857, p. 377.
Aplodes rubivora RILEY: 1st Rept. Ins. Mo., 1869, p. 139, pl. 2, fig. 25.
Aplodes rubivora. WALSH–RILEY: in Amer. Ent., i, 1869, p. 247 (ident. from New Jersey).
Aplodes rubivora. TREAT: in Amer. Ent.–Bot., ii, 1870, pp. 203–205, fig. 125.
Eunemoria gracilaria PACKARD: in 5th Rept. Peab. Acad. Sci., 1873, p. 77.
Synchlora albolineata PACKARD: in *id.* p. 75.
Aplodes rubivora. SAUNDERS: in Rept. Ent. Soc. Ont. for 1873. 1874, pp. 15, 16, fig. 10 (habits, etc.).
Synchlora rubivoraria PACKARD: Mon. Geomet. Moths, 1876, p. 382, pl. 10, fig. 85.
Synchlora rubivoraria. FRENCH: in Trans. Ill. Dept. Agr., xv, 1877, App., p. 288; in 7th Rept. Ins. Ill., 1878, p. 238 (brief description of larva and its habits); in Trans. Ill. St. Horticul. Soc. for 1881, n. s., xv, p. 198 (brief description).
Synchlora glaucaria (Guen.), HULST: in Entomolog. Amer., ii, 1886, p. 141.
Synchlora rubivoraria. SAUNDERS: Ins. Inj. Fruits, 1889, p. 316, fig. 330 (brief account).
Synchlora rubivora. EDWARDS (H.): Bull. 35, U. S. Nat. Mus., 1889, p. 102 (ref. to descr. early stages).
Synchlora rubivora. LINTNER: in Rural N. Yorker, L, 1891, p. 577 (larva and habits).
Synchlora rubivora. RILEY–HOWARD: in Insect Life, iv, 1891, p. 157 (in Jamaica).
Synchlora glaucaria. SMITH: List Lepidop. N. A., 1891, p. 57, no. 3460.

A Strange-looking Caterpillar.

That the two strange-looking caterpillars of this insect, received from New Haven, Conn., on the 27th of July, were the first of the kind that had come under my notice, would indicate not very acute powers of observation — unusual mimetic concealment in the larva — or that the insect is not of frequent occurrence in the State of New York.

The caterpillar and the moth that it produces are represented in the accompanying figure, but the reader, if not an entomologist may need to be told that the former is intended to be shown in the little irregular bunch adhering to the berry at *a*, and looking as if it were merely a roll of vegetable material that had been carried about in the winds before finding a temporary resting-place. Only upon examining carefully could the outline of a larval form be made out within it, nor would it then be accepted as a living being, unless it could be seen to unbend and commence to travel over the berry or to feed upon it.

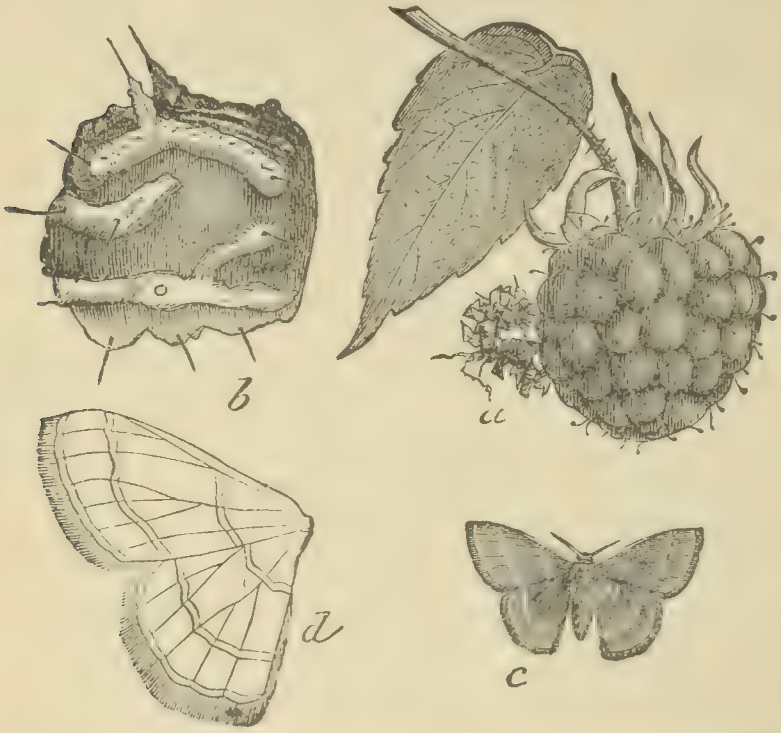

Fig 1.—The raspberry geometer, Synchlora glaucaria: *a*, the caterpillar; *b*, one of its segments enlarged to show the spines; *c*, the moth; *d*, wings enlarged. (After Riley.)

The raspberry geometer, as it is popularly called, is a small "measuring-worm," "inch-worm," or "looper"—names that are borrowed from the peculiar mode of progression in the family of *Geometridæ* to which it belongs, the caterpillars of which travel in a series of loops, as if surveying or measuring land. Supported on the terminal legs and extending the body to the utmost, they grasp the twig or leaf, and bring forward the hinder legs in contact with the front. The intermediate portions of the body which are unprovided with the legs that are present in most other families, are curved upward by the movement in the form of the capital letter omega in the Greek alphabet.

Concealment or Mimicry.

While many of the geometers when at rest extend their body upward from the branch in a straight line, counterfeiting almost exactly a twig, this one rests upon the berry in a close loop. When motionless in this position, no one would suspect it of being a living animal form. Its concealment is made almost perfect by the bits of vegetable material within which it hides itself. From its body a number of spines project, as shown in one of its enlarged segments at *b* in the figure. To these and at other points, it fastens the anthers of the raspberry blossoms and other bits of vegetation so thickly as to almost conceal its true form. It is strange that the anthers should be specially chosen for this purpose, but the fact has been stated by several writers, and the entire covering of the two received by me, consisted of these organs.

So perfect is the concealment of the caterpillar or its mimicry of a blighted blossom, that it might be supposed that the immunity from its natural enemies which it must secure in this manner would promote its multiplication and make it a quite common insect; but on the other hand, its disguise might easily, before it had attained a conspicuous size, permit of its being swallowed unsuspectingly with the berry. Indeed, a writer has remarked:* "The lovers of these most exquisite fruits, the raspberry and the blackberry, are often greatly disgusted by the discovery of the fact that instead of the delicious berry which they expected to enjoy, they are munching the small caterpillar under consideration."

The Caterpillar Described.

The caterpillar has been described by Professor Riley as follows:

Average length, 0.80 inch. Color light yellowish-gray, darker just behind each joint, and very minutely shagreened all over. On each segment a prominent pointed straight projection on each side of the dorsum, and several minor warts and prickles below. Two very slightly raised longitudinal lighter lines along the dorsum between the prominent prickles. Ten legs.

The above description, although brief, is probably all that will be needed for its identification, in consideration of its peculiar appearance and habits above given and illustrated.

The Moth.

The moth is a delicate creature, of about a half inch expanse of wings, of a pale green color, having both pairs of wings traversed by two whitish cross bands. More minutely described, to distinguish it from allied species:

Pea-green; a white stripe between the antennæ, which are also white, and beneath pale testaceous; palpi and legs white; front and pectus green; a green stripe on the fore trochanters. Palpi very long, extending out nearly twice the length of the head, greenish or reddish at the tip. Fore-wings with the costal edge white; a basal curved line, slightly dentate on the venules. Discal dot very linear, pale, obscure. Outer white line parallel with the outer edge, dentate on the venules; edge with white dots on the venules; fringe pale green. Secondaries with a much curved basal white line, a linear, small, white discal dot; outer line very dentate on the venules, much more so than the same line on fore wings; fringe pale, edge with white dots on ends of venules. Beneath, fore-wings testaceous, whitish on costal edge; fringe white;

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* 1st Report on the Insects of Missouri, 1869, p. 139.

anterior half of wings greenish, posterior [half] whitish. Secondaries whitish; the line appears, though very faintly. Abdomen green, streaked mesially with whitish. Length of body, ♂, 0.33; ♀, 0.43. Expanse of wings, 0.65—1.08. (*Packard.*)

Its Natural History.

The early life-history of the raspberry geometer is not known. Its eggs are probably deposited on the leaves of the raspberry and the blackberry near the blossom buds in May or June, according to the latitude, and the caterpillar feeds at first upon the tender leaves, but as soon as the berries begin to ripen they constitute its entire food. At or about the time of the ripening of the berries the caterpillar having reached maturity, it selects a suitable spot upon a leaf or twig where it forms a slight cocoon for its pupation. A few days only are passed in this stage when the moth makes its appearance — in the latter part of June in Texas, in July in Illinois, in August and September in New York and New England.

One of the two caterpillars received from New Haven either escaped from its box or was devoured by its associate; the other, after having fed for nearly two weeks upon raspberries, commenced making its cocoon on August 8th, and had completed it on the following day. Two days later (11th) the pupa could be seen through the thin meshes of the cocoon, of a pale brown color, with darker spots and lines, and about one-third of an inch in length. After a two weeks' pupation the moth was found in the box on the 23d of August.

A specimen in my collection bears date of August 3, 1873, taken at Schoharie, N. Y., and another from the collection of the late W. W. Hill, "July, 1871, Lewis Co., N. Y."

The Cocoon.

The inclosure for its pupation hardly deserves the name of a cocoon as it consisted only of about a dozen pieces of varying sizes taken from the sepals of the calyx of the berry, and arranged over its body and connected by some coarse threads, so few in number that they barely sufficed to hold the pieces together. The pupa was fastened within by its terminal tip caught in some silken threads.

Abundance and Distribution.

The principal interest pertaining to this insect lies in the possibility of its not being detected when the berries to which it is attached are eaten; but, in that event, no harm will ensue, or even a nauseous taste be experienced, such as attends the presence of one or two of the minute plant-bugs that so frequently infest the raspberry. It has never been known to occur in such numbers as to mar the fruit, although, according to Professor Riley, it has been somewhat numerous in Illinois. It has a large distribution over the United States, being reported by Dr. Packard from Maine, Massachusetts, New York, New Jersey, Missouri, Kansas, Texas, and Alabama. An example of apparently this species occurred among collections made by Mr. T. D. A. Cockerell, in Jamaica, West Indies.

Bucculatrix Canadensisella (Chamb.).

The Birch-leaf Bucculatrix.

(Ord. LEPIDOPTERA: Fam. TINEIDÆ.)

CHAMBERS: in Canad. Entomol., vii, 1875, p. 146 (imago); in U. S. Geolog.-Geograph. Surv., iv, 1875, p. 133 (citation).

LINTNER: "3d Rept. Ins. N. Y.," in 40th Rept. N. Y. St. Mus. N. H., 1887, p. 135.

PACKARD: 5th Rept. U. S. Entomolog. Commis., 1890, p. 507 (larva and moth), p. 508 (Tineid larva); in Insect Life, v, 1892, pp. 14–16, fig. 3 (occurrence in Rhode Island).

RILEY-HOWARD: in Insect Life, v, 1892, p. 16, fig. 3 (in New York, Mass., and parasitic attack).

FLETCHER: in Rept. Min. Agr. on Exper. Farms for 1892, pp. 156–158, fig. 14; same in Rept. Ent.-Bot , 1892, pp. 14–16, fig. 14 (general account).

Mrs. H. D. Graves, of Ausable Forks, N. Y., to whom many obligations are due for interesting and valuable observations made upon the insect pests of Northern New York, has kindly communicated the following notes upon recent operations of the above-named insect, under date of September 8, 1891:

The Insect at Ausable Forks.

I send herewith some birch leaves and worms, illustrating the condition of all the birches in this vicinity. The leaves sent are from a cut-leaf birch on my lawn. Lindens, maples, and dogwood standing near are entirely free from attack. In a ride of thirteen miles that I took through the country yesterday, all the birches could be distinguished at a long distance by their burned looking foliage, while all other trees were green and fresh. About three weeks ago I first noticed the falling of the leaves from my tree, but being busily occupied at the time I did not examine into the cause, and now the tree is spoiled for this year. I do not believe that there is a perfect leaf upon it.

The Insect at Scottsville.

The attack was recognized as identical with one that had come under my notice in the summer of 1886, through a letter and examples of the eaten foliage of a yellow birch, *Betula lutea*, and the infesting insect, received from Mr. Shelby Reed, of Scottsville, Monroe county, N. Y., as was briefly noticed in my "Third Report," as above cited. Mr. Reed, writing September 14th, stated: "Trees infested with the insect have a brown and scorched appearance, and light comes down through the thickest of the foliage as through a softened skylight."

The leaves sent for showing the injury to the foliage caused by the insect, had very nearly all of the green parenchymal matter eaten away, leaving only the transparent epidermis of one side as a thin transparent film. In a few instances only, had this film been broken or pierced into holes of microscopic size. It was interesting to see how thorough had been the work of dissecting out the parenchyma from between the epidermal reticulations. Only here and there had a cell escaped — all of them united, over the entire surface of some of the leaves, not exceeding a square quarter-inch. It was the most remarkable and beautiful leaf dissection that had ever come under my observation, far exceeding in delicacy any of the "skeletonizing" which we are often called upon to admire. That it could have been executed by so small a larva, seemed surprising, until it was learned from Mr. Reed that it was the concerted work of large numbers — forty-eight of the little caterpillars having been counted by him on a single leaf.

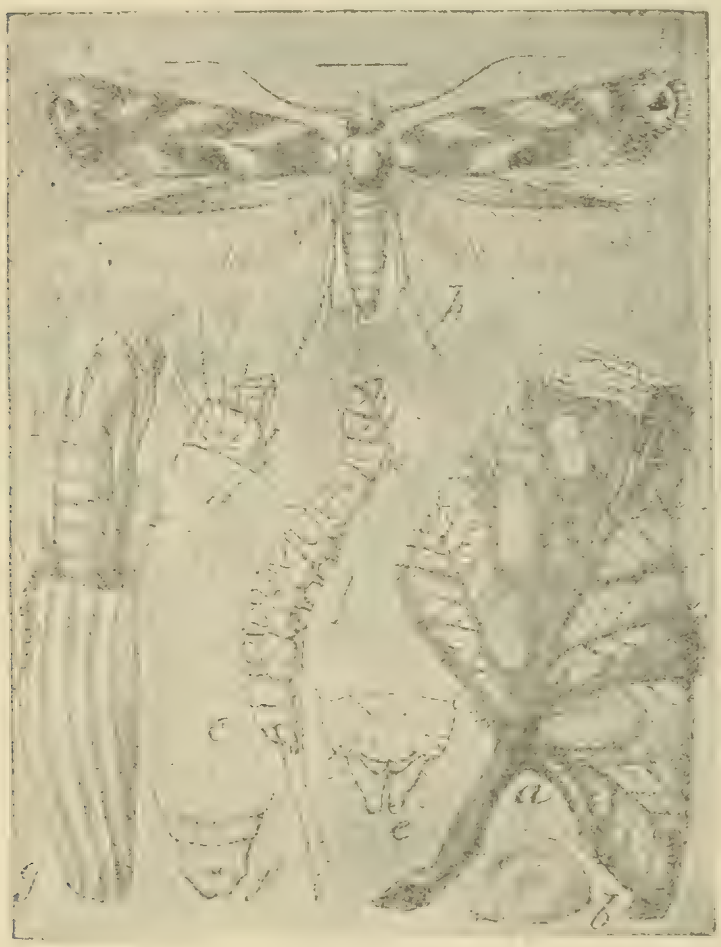

FIG. 2.— BUCCULATRIX CANADENSISELLA: *a*, skeletonized leaf; *b*. molting cocoon; *c*. larva; *d*. head of larva; *e*, anal segments of larva; *f*, same of pupa; *g*. cocoon with extruded pupa skin; *h*, moth — all enlarged. (From *Insect Life*.)

The leaves of the cut leaf birch received from Ausable Forks, were less eaten than the above — only about one-half, on an average, of the parenchymal matter having been removed. It is probable that the native birches, in their "burned looking" foliage, had been more seriously affected. At *a*, in Figure 2, a partly skeletonized leaf is shown.

The Caterpillar.

The full-grown caterpillar measures less than a quarter of an inch in length — more exactly, from 0.18 to 0.22 of an inch. It is of a slender form, tapering considerably at each extremity, and with deep incisures between the rounded segments. The head is long, projecting, slightly bilobed, of a pale brown color, with the ocelli and mandibles black; width of head about half that of the first segment, and one-fourth or less, of the central segments. The body is dull pale green, sometimes of a yellowish cast, having short hairs on the setiferous spots, and some longer ones elsewhere, particularly at the extremities, as shown at *c* in Figure 2, but omitted by the engraver in Figure 3. The terminal pair of prolegs are projected behind: the other prolegs are so short that the apodal segments also have the appearance of being employed for locomotion.

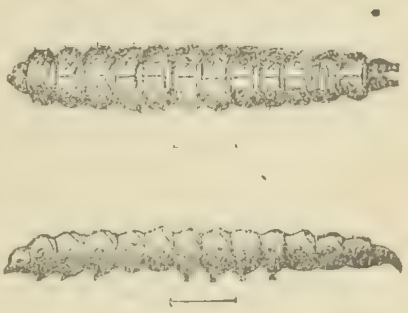

Fig. 3—Caterpillar of the birch-leaf Bucculatrix, Bucculatrix Canadensisella, side view and dorsal view (original.)

The caterpillar walks slowly, and when disturbed, drops from the leaf and hangs suspended by its thread. If brushed from the leaf to the table or a smooth surface, it twists vigorously about, in violent contortions, as if to frighten away, or to escape from, its enemies.

Its Molting Cocoon.

In addition to the two New York localities mentioned, the insect is also known to occur in Albany. After its reception from Ausable Forks, in Essex county, the birches in Washington Park were examined for it. Leaves eaten after the peculiar manner of the larvæ, to a moderate extent, were found, but none of the ribbed cocoons. On a number of the leaves were small rounded silken patches, which were identified as the retreats made by the larvæ during their molting periods—apparently in two sizes. They had been described by Dr. Packard, in the 5th Report of the U. S. Entomological Commission, as "Orbicular, 2 to 3 mm. in diameter, of white silk, inclosing the larva curled up within," and referred to an "unknown Tineid." Different names have been given to these interesting objects by recent writers, as cocoonets, cocoons, and pseudo-cocoons. They are, strictly speaking, cocoons, but as it might be confusing to refer to them by this name, any misapprehension would be prevented by calling them "molting cocoons," as suggested by Mr. Brunn in the first description of the structure. Their manner of construction, entrance into them, and occupancy will probably be found to agree with that of the larva of *Bucculatrix pomifoliella*, minutely given by Mr. A. E. Brunn, in the Second Report of the Department of Entomology of the Cornell

University Experiment Station, 1883, p. 158. As the publication is not accessible to many, the description is quoted:

> When the larva has made a mine from one-half to three-fourths inch long, which it does in from four to five days, it eats its way out through the upper surface; then somewhere on the upper surface of the leaf it weaves a circular silken covering about one-twelfth inch in diameter. Stretched out on this network, the larva, which is now 2.6 mm. long, makes a small hole in it near its edge, then, as one would turn a somersault, the larva puts its head into this hole and draws its body after. Arriving inside the "molting cocoon," as it may be termed, on its back and doubled in the shape of a horseshoe, the larva is then ready to strengthen the cocoon and close the opening which it made in entering. The larvæ make these cocoons in from fifteen to thirty minutes, and usually within two hours after leaving the mine. * * * Having molted, the larvæ leave their cast-off skins in the molting cocoons and cut their way out; they remain in these cocoons in most cases less than twenty-four hours.

The molting cocoon is represented at *b*, Figure 2, showing its peculiar central spot, or depression, or both.

The Cocoon.

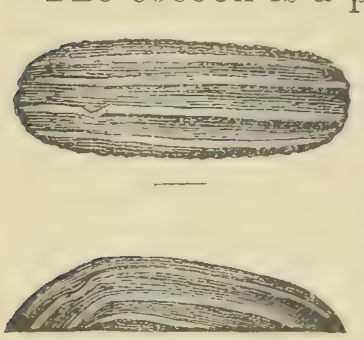

Fig. 4—Cocoon of the birch-leaf Bucculatrix, Bucculatrix Canadensisella; side view and from above (original).

The cocoon is a pretty little object with its five, or sometimes six, sharp ridges,* of which four are seen in a dorsal view, crossing over its entire length from one end to the other in parallel lines and uninterrupted except as they may be broken near one end where the cocoon is joined in its construction. The base is flat; the ends rounded; color, yellow-green. Length, 0.15 to 0.19 inch; breadth, 0.05 inch.

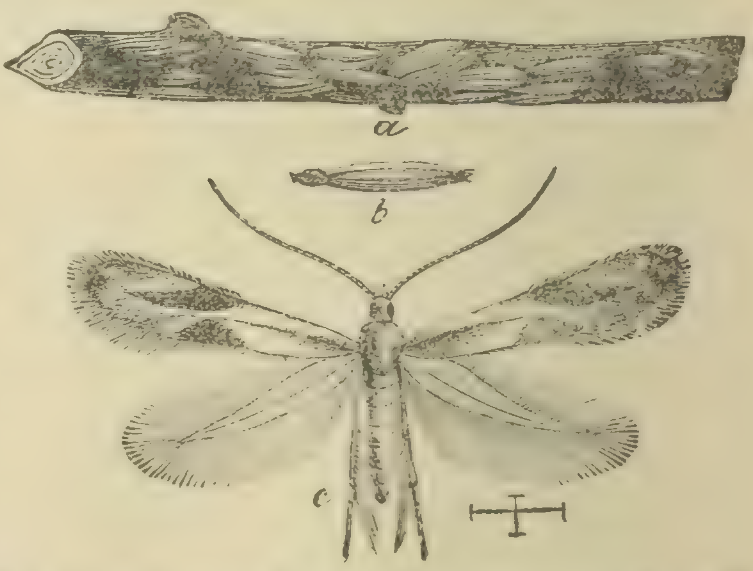

Fig. 5.—Apple-leaf Bucculatrix. Bucculatrix pomifoliella; *a*, piece of twig covered with cocoons; *b*, cocoon enlarged; *c*, the moth, enlarged.

It is quite different in appearance from that of *Bucculatrix pomifoliella* Clem., in several particulars, viz.: in its yellow-green color, instead of white; its sharper and more distinct ribs; its rounded instead of pointed ends; its base flattened to nearly its broadest diameter in place of being strongly contracted at the sides; its ridges distinct to the extreme tips instead of uniting near them; and the more conspicuous joining of the cocoon near one end. Cocoons are represented in

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*Mr. Fletcher (*loc. cit.*) gives "about eight prominent ridges," and Dr. Packard, "eight sharp, high ridges." I never saw them with so many.

Figures 2*g* and 4. Those of *Bucculatrix pomifoliella* are shown, for comparison at *a* and *b* in Figure 5.

The cocoons have only been observed upon the leaves, but as they are seemingly too few for such an abundant larval presence, it is probable that many of them are made on leaves that have fallen to the ground, or possibly, on or beneath the bark of the trunk, or even on adjoining trees and shrubs, as some of the species of Bucculatrix are known to have a fondness for traveling. None were found on the small twigs that have been sent me with the leaves.

The construction of the cocoon is an interesting operation to watch. It differs in method from that with which we are familiar in many of the Bombycid and other moths where the caterpillar spins its thread around it, and gradually hides itself from view. In its early life the birch-leaf caterpillar had been an outside builder, as will be noticed hereafter, and its habit is not abandoned in this its mature stage.

The cocoon is apparently commenced by the caterpillar marking out with a few threads laid upon the surface of the leaf the outline of one end. From this, as the base of operations, the ribbed walls are built up in the following manner: Its thread is fastened at one end of the basal line, and then carried over in the required curve and at a slight elevation to the other side where it is fastened to the base. The thread continues to be carried from one side to the other, but not in single curves made by one sweep of the larval head. If closely noticed through a lens (as these observations were made), the head will be seen moving in a series of concave curves, resting momentarily at the four or five points where the ribs are being formed. Thread after thread is thus rapidly carried over; the base is gradually widened as it approaches the middle part: the short curved sweeps of the larval head build in the ribs and the depressed portion between them, while each thread is applied, and apparently adheres closely, to the preceding. This is continued without cessation, and as the building progresses the caterpillar gradually moves backward before its advance. Whether its eyes or the length of its head serves as the only measure for the diameter of the cocoon is not known. Possibly its body may be used as a guide after the manner of the caterpillar of a Limenitis butterfly, which repeatedly during the construction of its hibernaculum creeps within it as if to test the dimensions of the silken-lined leaf-tube within which, with entrance left unclosed, it is destined to pass the winter.

When the cocoon is about three-fourths completed, a new procedure ensues: the caterpillar arrests its work, turns itself about, and moves backward within its walls — its head and two or three of its segments projecting. The other end is now commenced, and is extended backward on the same plan and in the same manner as before, until the two portions are united. Sometimes the joining is so accurately made that it can hardly be detected; the ridges are in exact line and only a slight elevation or other irregularity is visible. In others the ridges, instead of aligning, are interposed at the suture, and a perceptible hump marks the place. For a short time longer the caterpillar may be seen through the translucent walls, actively twisting its front segments backward and forward, as additional threads are being thrown over the joining to unite the two portions, and the strikingly ingenious piece of insect architecture is finished.

Since the above was written my attention has been drawn to the detailed account given by Mr. Chambers in the *Canadian Entomologist,* vol. xiv, 1882, pp. 157–160, of the building of the cocoon of another species of *Bucculatrix*, viz., *B. ambrosiæfoliella.* It differs materially from that above described, in that "a reticulated framework" is at first constructed (of which a diagram is given by Mr. Chambers), and "the cocoon proper" afterward spun within it.

No specimens of the cocoons of *B. Canadensisella* are at hand which would serve to show if they also are double, but I would expect to find them single — simply reinforced with additional threads within.

I am unable to reconcile what I saw, or at least thought that I saw, in the construction of the cocoon of *B. Canadensisella* as above described, with Mr. Fletcher's account of the same operation, given in his Annual Report for 1892 (*loc. cit.*): "A mat was first spun on the surface of the leaf, then the foundations of the ribs were begun. Little by little they were continued, and the meshes of an open network stretched between them, the caterpillar all the while retreating backwards as the structure advanced."

There was certainly no "open network" in the cocoons that my caterpillars built before my eyes. Strange that they should have done so differently from what they ought to have done "according to the books." Mr. Chambers, who was a close student of the habits of Bucculatrix larvæ, has stated: "All other known species of the genus, save one, make these ribbed cocoons, and to do so, they must work much as this [*ambrosiæfoliella*] does."

The building of the cocoon of the common *B. pomifoliella* has probably never been observed, as no account of it has been given to us.

The Moth.

The moth is so well shown in Figure 2, that it can hardly fail of recognition when the comparison is made, but, as of possible service to the student, the original description by Mr. Chambers is transcribed:

Head white; tuft tipped with dark reddish-brown, and the face faintly tinged with purplish fuscous. Upper surface of the thorax brown margined by white. Base of the fore-wings white, followed by an oblique brown fascia, which is nearest the base on the costal margin, and is followed by an oblique parallel white fascia; all of these are placed before the middle, and are followed by a large brown patch which occupies the entire wing to the ciliæ [cilia], except that it contains a white spot on the middle of the costal margin; the brown patch is margined before on the dorsal margin of the wing by a small tuft of raised brown scales; at the beginning of the dorsal ciliæ is a white spot placed a little before, but becomes almost confluent with a longer white costal streak; behind these streaks to the apex of the wing is pale brown, with a darker velvety brown apical spot; ciliæ pale yellowish, with a dark brown hinder marginal line before their middle, not extending to the costal ciliæ. Expanse of wings, three-eighths of an inch.— From Canada.

Mr. Fletcher's description of the fore-wings will give a better idea of their general appearance:

Wings crossed with silvery white bars; three of these run from the outer edge about half way across the wings obliquely toward the apex, and there are two shorter subtriangular blotches on the inner margin of each fore-wing. These latter, when the wings are closed, form two white dorsal saddles, the anterior of which is slightly the larger and is followed closely by a tuft of raised black scales. At the extremity of the fore-wings are also several raised black scales, a few of which are separated into an apical spot by an irregular narrow white band. The cilia of the fringes are pale brown.

Life-history and Habits.

The life-history of this insect is as yet unknown. Neither the eggs of the moth or the mining operations of the larvæ have been observed. The following seems to be about all that is known of the insect:

Larvæ had built their cocoons at Ausable Forks, N. Y., on September 8, 1886. Of examples received from Monroe county, N. Y., on September fourteenth, a few had already made their cocoons, and the following day nearly all had completed or commenced their construction. The larva eats the parenchyma out of both sides of the leaf. In confinement it walks slowly, often dropping down and hanging by a thread. The first week in September larvæ were seen within their molting cocoons, and previous to that had been noticed feeding exposed and eating little holes in the upper surface of the leaves, at Brunswick, Me.

They were abundant in Massachusetts during the second week in September, 1892, on *Betula populifera.* (Packard.)

Larvæ received September 13 and 15, 1890, from Massachusetts, gave cocoons later, moths from which emerged from January until March. (Riley–Howard.)

The injuries of the larvæ become noticeable in August, when the leaves assume a rusty or burned appearance and fall prematurely. Since 1890, all varieties of birches in the vicinity of Ottawa have been attacked, but *Betula alba* most severely; *B. papyrifera* and *B. lutea* almost as severely. They are particularly partial to the European cut-leaf weeping-birch. A few cocoons have been found on twigs, but the main body must spin elsewhere. They are not spun on the leaves except in confinement. (Fletcher.)

Distribution.

Thus far, the insect has only been reported from Canada, New England States, and New York, but it will undoubtedly be found to have a wider distribution. It was originally described from specimens received from Mr. F H. Belenger of the Université Laval, Quebec. The recorded localities are Ottawa and vicinity (Fletcher). Brunswick, Me.; Bristol county, Mass.; Providence, R. I. (Packard). East Norton and West Bridgewater, Mass. (Riley–Howard). Scottsville, Plattsburg, and Albany (Lintner).

Remedy.

Whenever it shall be found necessary to check the attacks of this insect, on ornamental or shade trees, it can be done by spraying the foliage of the infested tree during the latter part of August or the first of September with a weak mixture of Paris green or London purple—one pound to 300 gallons of water.

Diplosis pyrivora Riley.

The Pear Midge.

(Ord. Diptera: Fam. Cecidomyidæ.)

? *Cecidomyia nigra* Meigen: Syst. Beschr. bek. europ Zweifl. Insek., 1818, pl. iii, fig. 11; cited in Macquart's Hist. Nat. Ins.-Dipt., i, 1834, p. 161.

? *Cecidomyia nigra* Meig.: Schmidberger, in Kollar's Ins. Inj. Gard.-For.-Farm., 1840, pp. 292–295 (general account).

? *Cecidomyia pyricola* Nördlinger: Die Kleinen Feinde, 1869, p. 622.

Cecidomyia nigra: Ormerod: [7th] Rept. Obs. Inj. Ins., 1884, pp. 52–54 (operations, habits, remedies).

Cecidomyid larva SMITH: in Ann. Rept. Dept. Agricul. for 1884. 1885, pp. 396–398, pl. 9, fig. 6 (at Meriden, Conn., larva figured).

Diplosis nigra [?]. RILEY: in Ann. Rept. Dept. Agricul. for 1885. 1886, pp. 283–289, pl. 7, figs. 2, 3, 4 (history, habits, description, remedies, etc.); in Wien. Entomolog. Zeit., vi, 1887, p. 201.

Diplosis pyrivora RILEY–HOWARD: in Insect Life, i, 1888, p. 120 (in England); in *id.*, ii, 1889 (in England); in *id.*, iv, 1891, p. 161 (in New York).

Diplosis pyrivora. MEADE: in Entomologist, xxi, 1888, pp. 123–131.

Cecidomyia nigra. BLOOMFIELD: in Ent. Month. Mag., xxiv, 1888, p, 273 (operations in England); in *id.*, xxv, 1889, p. 323.

Diplosis pyrivora. LINTNER: in Albany Eve. Journ., May 30, 1891, p. 8, c. 1; in The [New York] Sun, June 1, 1891, p. 3, c. 5; in Oswego Daily Times, June 3, 1891, p. 5, c. 2, 3; in Garden and Forest, June 10, iv, 1891, p. 276; in New Engl. Homestead, June 13, 1891, xxv, p. 249, c. 4; in Canad. Entomol. xxiii, 1891, p. 223.

Pear midge. COE: in Count. Gent., lvi, 1891, p. 896 (injuries lessening).

Diplosis pyrivora. SMITH: in Insect Life, iv, 1891, p. 45 (in New Jersey); in Ann. Rept. N. J. Agr. Exp. St. for 1891, pp. 397–402, figs. 18, 19 (life-history, spread, remedies); in Insect Life, v, 1892, p. 94 (in New Jersey).

Cecidomyia nigra Meig. RITZEMA BOS.: Tierische Schädlinge und Nützlinge, 1891, p. 587.

Cecidomyia nigra Meig. THEOBALD: British Flies, 1892, p. 64 (in England).

The Pear-tree Seriously Attacked.

It is quite remarkable that while the apple tree has drawn to it, in this country, 280 known species of attacking insects, and a large number of them quite injurious ones, the pear tree should have so long escaped with but a moderate amount of insect injury, either to its trunk, its foliage or to the fruit. Its worst enemies have never been very destructive, and nearly all of them are only of occasional occurrence and local in their operations. Mr. E. P. Powell, a successful pear grower in central New York, has recently written: "The apple has four serious enemies [referring to the codling-moth, the tent-caterpillar, the apple-tree aphis and the fall web-worm], while apart from blight, the pear has none."

At the present time, this favorable condition of the pear seems to be seriously threatened, and pear growers in the Hudson river valley are confronted with two small insect pests, either of which, should it continue to multiply and extend, as it gives promise of doing, would prove a greater obstacle to successful pear culture than all of our other pear insects combined. While the pear midge confines its operations to the fruit, the pear Psylla not only blights the fruit but may so impair the vitality of the tree as eventually to kill it. This last-named insect will be noticed hereafter.

What the Pear Midge Is.

The perfect insect is a small, grayish-colored, delicate-winged, slender-bodied, long-legged fly, of the general appearance of the minute flies which are commonly known as gnats or midges. With its wings expanded, its spread would be about one-fifth of an inch. It is represented in Figure 6, at *a*. The larva of the fly, found feeding within the young fruit, when full-grown, about the first of June, is a thick-bodied, pale-yellow, footless "maggot" (as the larva of flies is usually called), somewhat pointed at the ends, and of about one-tenth of an inch in length. Those familiar with the appearance of the wheat-midge (*Diplosis tritici*), commonly known as the "weevil," would at once recognize the resemblance of the two forms, as they belong to the same genus, and are not much unlike.

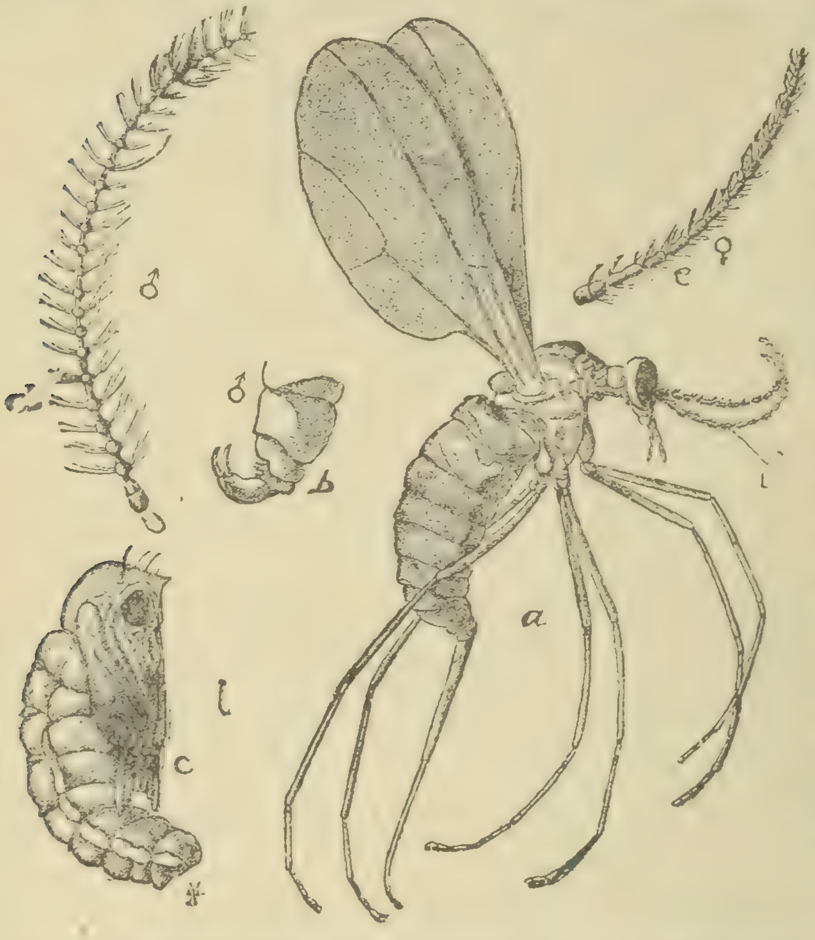

Fig. 6.— The Pear Midge, Diplosis pyrivora: *a*, the female, side view; *b*, genitalia of male, from side; *c*, pupa — all much enlarged; *d*, antenna of male; *e*, antenna of female, still more enlarged.

Its First Notice in the United States.

It is believed that this insect is an European species, and that it was introduced in this country in the year 1877, in an importation by Messrs. Coe Brothers, of Meriden, Conn., of pear stocks from France — the pupæ being contained in the soil adhering to the roots. Two years after this importation (1879) the deformation of the fruit caused by the insect was noticed in the Coe orchards — at first in the Lawrence pear, and afterwards extending to other varieties. Each following year showed a marked increase, and in 1883 it had multiplied to such an extent as to destroy nearly the entire crop of the extensive pear orchards of 600 trees. At this time the attention of the Division of Entomology of the United States Department of Agriculture was called to the new and unknown pest, and in response the locality was visited by Mr. John B. Smith of the Entomological Division, who made report upon it, as published in the Annual Report of the Department for that year. A more extended report was made by Dr. Riley in the year following, embracing figures of the insect, its life-history and habits, and detailed descriptions, under the name of *Diplosis ?nigra* Meigen. From this report the figures of the insect herewith presented, are drawn, as also the facts relating to its introduction as above given.

Identity with the European Species.

Although there seems to be but little question of its identity with the species described by Meigen as *Cecidomyia nigra*, yet as not a single specimen of Meigen's *nigra* can be found for comparison in any of the European collections, and as the original description is quite imperfect, Dr. Riley was advised by the European authorities to redescribe and rename it, which he has accordingly done, designating it as *Diplosis pyrivora.* The name was subsequently accepted by R. H. Meade and other eminent dipterologists in Europe.

Efforts for Its Extermination at Meriden.

Realizing the importance of suppressing so destructive a fruit pest while confined in its limited locality, the Messrs. Coe resorted to the heroic treatment of picking off their entire crop of pears in 1883, it being an "off year" when the yield was comparatively light, and burning it with the contained larvæ. But before the entire completion of the task a heavy rain set in, which caused the infested fruit to break open and release the inmates. When the work was resumed it proved to be too late, as all of the larvæ had deserted the fruit and entered the ground. It was also discovered that a neighboring orchard had become infested. But for these two unfortunate circumstances — or if the effort had been made a little more timely, there is every probability that the insect might have been exterminated, and losses to our fruit growers which may run into the millions of dollars might have been prevented.

It was hoped that the spread of the insect had been largely arrested by the above means, as nothing had been heard of its presence in other localities for the ensuing six years.

Discovered at Catskill, N. Y.

During the last week in May of the present year (1891), some young pears were sent to me from Catskill, N. Y., with the inquiry of the name of the attacking insect. The nature of the inquiry was not evident at the first inspection, as the fruit was fair, unbroken, and showed no external injury — its peculiar deformation being unnoticed. But upon cutting into one the interior was found to be occupied by a large company of active little bodies which, wriggling out and dropping to the table, commenced to give evidence of their sharing in the saltatory powers belonging to many of the Cecidomyids and particularly to the genus *Diplosis*, by throwing themselves from a small box in which some had been placed to a distance of two inches and more in a single bound. The attack upon the fruit was at once recognized as that of the pear midge, *Diplosis pyrivora*.

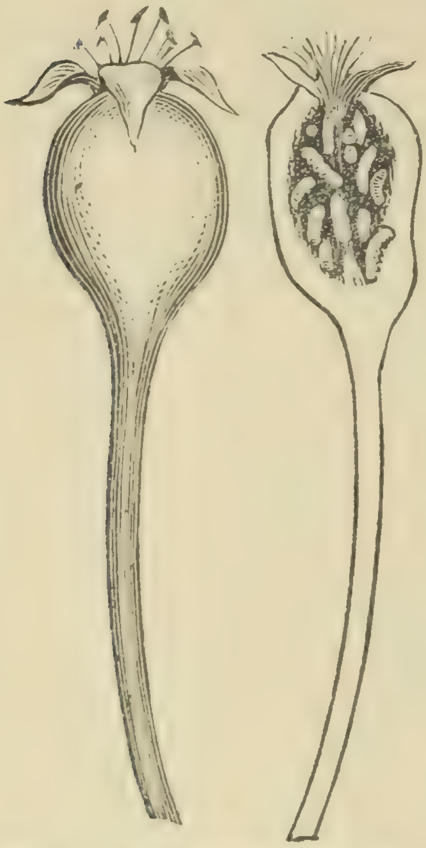
Fig. 7.— Section of a pear containing the larvæ, and an uninfested one for comparison of forms (original).

In a visit to Catskill immediately following this discovery, all the orchards that could be examined during the day, within a radius of two miles, were found badly infested with the insect, and its presence in other orchards more distant was reported. In those of Mr. Theodore A. Cole, where it was first detected, the attack was the most severe. There were here many old and quite large Lawrence pear-trees, heavily laden with fruit, but an examination showed that at the least ninety per cent of the fruit was filled with the full-grown midge larvæ. Other varieties were infested in a less degree, among which were the Vicar, Anjou, Seckel, Bartlett, and Buerre Bosc. Mr. Cole had observed the attack in his orchards four years previous (in 1887); in 1889 the Lawrences were almost entirely destroyed by it. He had neglected calling attention to it until the present season, thinking that it was a well-known trouble which could not be prevented.

In passing over the orchards and observing so large a proportion of the fruit infested, Mr. Cole asked—"how can this condition follow a year (1890) in which I had no pears: where did the midge breed?" This could not be answered until, upon coming to some Buerre Bosc trees which were now for the first time found to contain the larvæ, Mr. Cole recalled the fact that this variety had borne some fruit the preceding year and was the only one that had done so. How the midge had been carried over "a no pear year" was at once satisfactorily explained. Had there been absolutely *no* fruit in which the larvæ could have fed within reach of the flight of the parent midge at the time for its oviposition, the species would probably have been exterminated within that locality, for it is not known to occur in any other fruit than the pear. It is possible, however, that if there should be in any year no pear-blossoms to receive the eggs, that the midge might resort to apple trees for oviposition, and thus originate a new food-plant for its perpetuation. This consideration may have a bearing in the direction of methods for the extermination of the pest.

Deformation of the Infested Fruit.

The presence of the larvæ within the fruit causes it to enlarge and swell out irregularly, assuming various forms, — the most marked and striking of which are represented in the accompanying illustration.

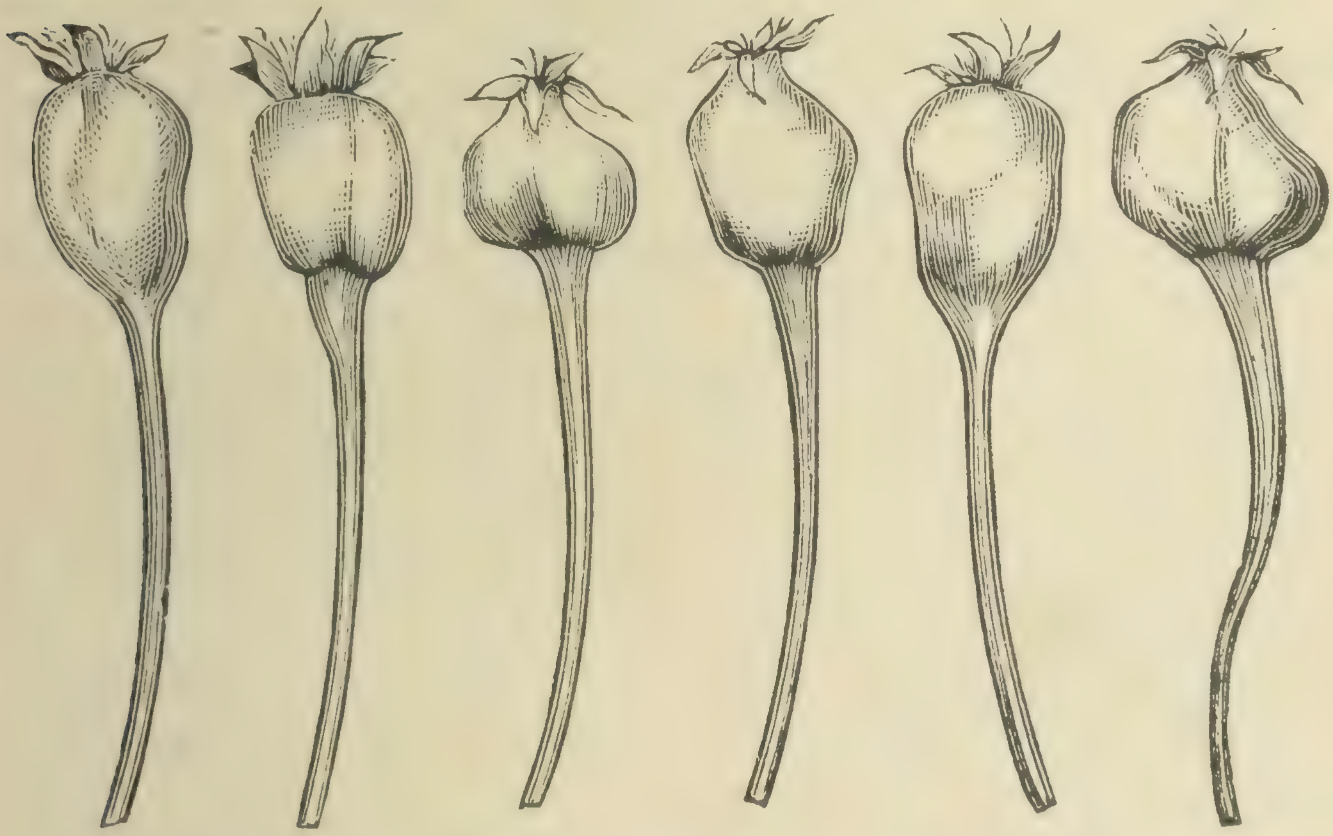

Fig. 8 — Young pears deformed by the pear-midge larvæ — natural size. (Original.)

The more usual form observed about the 1st of June when the larvæ have attained maturity, is that in which the upper three-fourths of the pear has become enlarged and swollen out into irregular protuberances, and showing an abnormal color, quite in contrast with that of the seemingly contracted base.

So conspicuous are these features that every infested pear on a tree can be recognized without difficulty. Any that are without distortion and of normal shape, if cut open, would be found entirely free from attack.

Much earlier than this, according to Mr. Cole, the midged fruit can be readily detected — more easily, if possible, than at a later period; for soon after the falling of the blossoms, the operations of the larvæ cause a marked enlargement of the forming fruit, which is presumably (although it was not so stated) accompanied with more or less distortion.

On cutting open the fruit, a large central cavity is seen within it, occupying most of its interior, quite irregular in form and often made up of smaller cavities separated by thin walls or by the remains of the core. Among these the larvæ are distributed, instead of being collected in one mass. Repeatedly, when all had been removed that were at first visible, sometimes as many more could be extracted or would creep out from side cavities. The average number of larvæ occurring in the Catskill fruit may be stated at twenty. In one pear thirty-four were counted.

How the Larvæ Leave the Fruit.

The infested fruit does not fall from the tree. The first rain of several hours' duration that may occur about the 1st of June causes the fruit to crack open, sometimes at different points, but often in an interrupted line around the enlarged portion near the base. Through these gaping openings the larvæ, now mature, find easy egress, when they at once emerge and drop to the ground. Or the rain, under different conditions of the fruit, may cause it to soften, blacken and decay in spots, and these would serve as outlets for the larvæ. So eager do they seem to be for their escape that a rain of twenty-four hours' duration would be followed by the emergence of considerably the greater part of them within a day thereafter.

Wet, and its attendant breaking down of the structure of the pear, seems indispensible for freeing the larvæ and their subsequent development. I have not known them to emerge through the calyx end, and do not believe that they ever do so. Some infested fruit picked on the 25th of May before rain had fallen and brought to my office, gradually dried up unbroken and blackened, without releasing a single one of its occupants. On the 15th of June living larvæ only were contained in the dried fruit. On the 25th of August a few of the larvæ were still alive, but most had died; at the present date, October 10th, all that I examine are dead and hardened. The fruit, having given out its larvæ as above described, continues to hang upon the tree for a while thereafter, but in a few days shrinks, blackens, and falls to the ground. Under date of June 10th Mr. Cole reported that nearly all of the midged pears had, at that time, fallen.

The Larva Described.

The following description is extracted from Dr. Riley's Entomological Report for the year 1885, together with the accompanying figures:

Length 4^{mm} to 4.5^{mm}. Color, pale yellow. Surface polished and very faintly reticulated. Breastbone pale brownish, its apex broadly bilobed. (In the figure it is represented as rather too long for its width.) Body (thirteen joints and subjoint) fourteen-jointed, exclusive of the head. Antenna two-jointed. Anal subjoint much narrower laterally than the penultimate, slightly concave, the concavity beset with six (three each side) small, fleshy tubercles (the two middle ones are not shown in the figure), of which the second one on each side is stoutest, those on the external angles bearing each a short spine. Spiracles normally placed and mounted on tubercles.

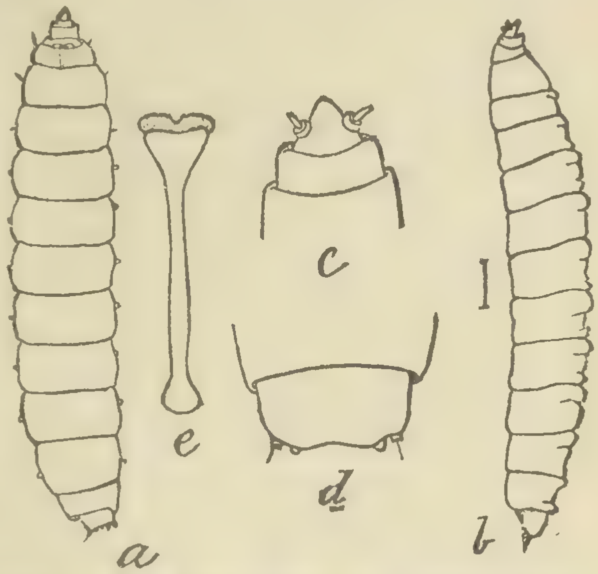

Fig. 9.—The pear-midge: *a*, dorsal view of the larva; *b*, side view; *c*, head and front segments; *d*, last segment; *e*, "breastbone"—all much enlarged.

Entering the Ground for Pupation.

Pears received from Catskill, through the kindness of Mr. Cole, on the 30th of May, after they had been exposed to a heavy rain and were cracking open freely, were already giving out their larvæ very abundantly. About five hundred of these were given common earth in a flower pot, which they speedily entered. The pot was buried in my garden, with its top at the surface of the ground, where it will be left until the coming spring under conditions natural to the insect. A still larger number were given, on June 8th, damp molding sand for burial, as offering facilities for their occasional observation. A jar of these containing two hundred was carefully examined a week thereafter (June 15th), when a single cocoon was found at the depth of a half-inch, several at one inch, a number at one inch and a half, thence to two inches a large number, and to two and one-half inches quite as many; below this none were found. All but four of the larvæ had made cocoons, and these had evidently received some harm. It may be inferred from the above that in ordinary soil, not as penetrable as the molding sand, the larvæ ordinarily bury at a depth of between one and two inches. A cocoon opened July 6th contained the larva with a thin pellicle attached to its terminal end which had apparently been cast off by it.

Pupation.

The pupation is within an oval cocoon, composed (in the above) of grains of the sand united and lined with yellowish silk, somewhat flattened, with its longest diameter exceeding its transverse by about one-half. The cocoons differ perceptibly in size, but average one-tenth of an inch in length,—ten taken at random measuring just one inch.

Opening a few of the cocoons on October 12th, somewhat more than half had changed to pupæ. These agreed with the description given of this stage by Dr. Riley in his Report for 1885 (*loc. cit.*), but differed in the examples examined from his figure (see *c* in figure) in that the leg-cases reached quite to the tip of the abdomen, even when straightly extended, instead of only to its sixth segment.

The larvæ that were planted out of doors have not been examined, but it is probable that they will hibernate in the larval stage.

At Washington, the winged midge was obtained from examples bred in the warmer temperature of the vivarium during the months of January and February,* while others, presumably under natural exposure, emerged from April 10th to 13th. Their usual time of appearance is probably coincident with the putting out of the blossom buds of the pear.

The Winged Insect.

The general appearance of the midge is represented in Figure 6. Its more conspicuous features, borrowed from Dr. Riley's detailed description, are these: The male. Average length, one-tenth inch; general color, dark gray or black; eyes, deep velvety black; antennæ, one-fifth longer than the body, black, with twenty-six globose joints; thorax, dark dull gray or black, with two diverging rather indistinct gray stripes, and beset with long yellowish hairs; wings, slightly smoky, darker veined and covered with a sparse black pubescence, and having a black fringe; halteres, or balancers, pale yellow; legs, dusky with a yellowish tinge; abdomen, dark gray, almost black dorsally, terminating in a pair of two-jointed claspers, shown in enlargement in Figure 10, in which *b* are the claspers and *c* the intromittent organ.

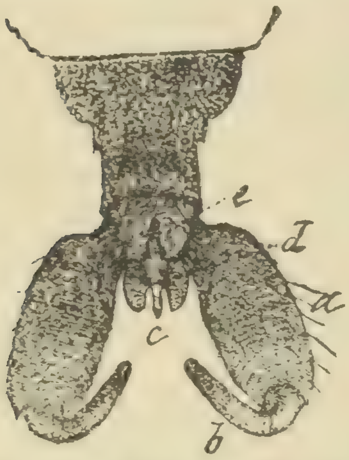

FIG. 10.—Genitalia of the male pear midge, DIPLOSIS PYRIVORA. (After Riley.)

Female, 0.13 in. long, exclusive of ovipositor, which extended is as long as the abdomen. Antennæ, fourteen-jointed, slightly longer than the head and thorax together. General color somewhat lighter than the male.

The Egg-laying.

I know nothing, personally, of the oviposition of the midge, nor have I knowledge of any other record of it than what is based on Schmidberger's observations as recorded of *Diplosis nigra* in *loc. cit.* This is so circumstantial, that it seems deserving of acceptance as having been carefully observed by him, and conclusive as to the time and manner of the egg-deposit. That the eggs are deposited in the blossom, rather than in the young fruit as believed by some, * finds seeming confirmation in the fact stated by Mr. Cole, that upon the falling of the blossom petals and the first forming of the fruit, the presence of the larvæ may be already detected in the abnormal growth.

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*Schmidberger had it emerge as early as the 28th of December.

Schmidberger's account is as follows:

> When the blossom-buds of the pear-tree were so far developed that in the single blossoms a petal showed itself between the segments of the calyx, I found the first gall-midge in the act of laying its eggs in the blossom; this was on the 12th of April. It had fixed itself almost perpendicularly in the middle of a single blossom, and having pierced the petal through with its long ovipositor, it laid its eggs on the anthers of the still closed blossom. The female was about seven and a half minutes in laying her eggs. When she had flown away, I cut the pierced bud in two, and found the eggs lying in a heap one upon another on the anthers. They were white, longish, on one side pointed and transparent, and from ten to twelve in number. I afterwards found several midges engaged in laying their eggs, as late as the 18th of April, from which day they ceased to appear in the garden. I also saw a gall-midge on the side of a blossom with its ovipositor inserted in it, so that they do not merely pierce the petals but the calyx also. I even saw one, which having been somewhat long in laying its eggs, could not draw out the ovipositor from the blossom; the cause of which I conceived to be, that the wound had begun to close during the operation, and the ovipositor was thereby held.

Schmidberger further states that the eggs are quickly hatched in warm weather, for on the fourth day after the deposit he had found the small larvæ on the embryo blossom. They bore into it near the calyx, and before the blossom is expanded, they descend to the core, so as not to be exposed to the rays of the sun. They separate at the core and begin to devour on all sides.

Distribution of the Midge.

The midge still continues its work at Meriden, Conn., where it was first detected, but with less severity than at first. Mr. Coe has written to me recently that it has this year taken one-half of his Lawrence and Dana pears on about three hundred trees.

When first discovered at Catskill, I thought it probable that it had been brought in trees purchased in Meriden, but was assured that none had been introduced from that locality or imported from abroad.

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* See Professor J. B. Smith, in *Insect Life*, iv, 1891, p. 45.

In a visit made to the pear-orchards of Mr. George T. Powell at Ghent, N. Y., on June 8th, the work of the midge was seen, although less severe than at Catskill, but occurring in a larger number of varieties of the fruit.

At this date, all the fruit attacked had passed its knobby, swollen, gall-like stage, and had become shriveled and black and more or less cracked or broken about the base, while still fast on the trees. Upon cutting them open the irregular cavity within showed the work of the larvæ. In a few instances some of the larvæ still remained within the fruit.

Ghent is fifteen miles in direct line from Catskill, and each locality is about ninety miles from Meriden. It is probable that the attack has been gradually extending westerly (presumably in other directions also) until it has reached the fruit region of the Hudson river valley, where, unless efficient means can be found for its control, it will continue to extend its range. It is reported as quite bad at Athens, six miles to the north of Catskill. It has not yet reached as far north as Albany, in force, although it is actually present in this locality, for examination of pear trees in gardens in the city, gave me a single pear hanging on a tree, June 6th, which had unmistakably harbored and given out the midge larvæ.

Remedies.

From the peculiar concealment of this insect within the fruit during its egg and larval growth to maturity, where it is effectually beyond the reach of the sprayed insecticides, the question of how it can be reached and destroyed, finds no ready answer. At first sight, it would seem, that since every infested pear can be readily and unerringly recognized, the method adopted at Meriden of picking and burning the infested fruit while containing the larvæ, would be all that could be desired. This would not be a difficult task in a young orchard, but when trees have attained the size of the Lawrences growing in the orchard of Mr. Cole at Catskill, viz., twenty-five feet in height with a spread of about twenty feet, it is virtually impracticable.

Mr. Cole at first thought of meeting the difficulty by cutting down and burning in the following month of May, after the oviposition of the midge, all of the old and large Lawrence trees which were yielding him scarcely any fruit. On reflection, he concluded that they might serve a more valuable purpose by allowing them to stand as lures for the reception of much the larger proportion of the eggs that would be deposited by the midges in an orchard of different varieties. As soon as the time of oviposition had passed, which would be before the blossoms had fallen, the blossoms could be sprayed with some substance that would blight them, when the larvæ, being left without their food, would die. In the discussion of this proposed remedy by the Entomological Club of the A. A. A. S. at its recent Washington meeting, Mr. Fletcher, Entomologist and Botanist of the Government Experimental Farms of the Dominion of Canada, suggested that the blighting might be done by the arsenites, and preferably, by London purple on account of its causticity; but if there was possibility that honey bees visiting the blossoms might be injured thereby, sulphate of copper might be used instead.*

A few years' sacrifice of the Lawrence pear crop, in the above manner, should tend largely toward the reduction in numbers of the midge. It is probable that the other pears do not offer as favorable conditions for its multiplication. Should the Dana's Hovey, or some other variety hereafter be found almost as attractive as the Lawrence, it also, in turn, might be given the same treatment. When by this means the insects have been largely reduced, it would not be difficult to control the attack by hand-picking and burning.

Another means of destroying the insect after it has left the tree is this: The larvæ, upon dropping to the ground, enter it to the moderate depth of an inch or two, where they remain in their larval stage for two or three weeks before they inclose themselves within their cocoons. At this time they could be reached and killed by spraying over the ground directly beneath the trees a strong kerosene emulsion. Experiment and examination would show the maximum amount of the liquid required. The cost of this would be very slight in comparison with the value of the pears saved. Or the same end would probably be attained by spreading lime or ashes on the ground, to be carried into it either by the rain or by sprinkling with water. Of course, if these measures were delayed until after the larvæ were sheltered within their cocoons, their efficacy would be impaired. It must also be evident that if this destructive pest is to be controlled, that just so far as it is found to have extended, all pear growers should unite in an earnest effort for its extermination. A golden opportunity was lost while it was limited to the Coe Brothers' orchard at Meriden, but it seems to be quite practicable to prevent its spread much beyond its present range.

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* *Canadian Entomologist*, xxiii, 1891, p. 224.

Clastoptera obtusa (Say).

The Obtuse Clastoptera.

(Order HEMIPTERA: Subord. HOMOPTERA: Fam. CERCOPIDÆ.)

SAY: Descr. New Hemip. Ins. in Exp. Rocky Mts., Journ. Acad. Nat. Sci. Phila. iv, 1825, p. 339; Compl. Writings, ii, 1886, p. 256 (as *Cercopis*).

FITCH: in 4th Ann. Rept. [N. Y.] St. Cab. N. H., 1851, p. 53 (? *C achatina* Germ.); in Trans. N. Y. Agr. Soc. for 1856, xvi, p. 466; 3d Rept. Ins. N. Y. (in 3d–5th Repts.), 1859, p. 148, no. 192 (characterized).

GLOVER: in Rept. Commis. Agricul. for 1876. 1877, p. 31, f. 29 (brief notice).

UHLER: in Cassino's Stand. Nat. Hist., ii, 1884, p. 244 (its features).

COMSTOCK: Introduc. Entomol., 1888, p. 178 (from Uhler).

PROVANCHER: Pet. Faun. Ent. Can.—Hemipt., 1889, p. 259 (description).

LINTNER: 5th Rept. Ins. N. Y., 1889, p. [100] 242; in 42d Rept. St. Mus., 1889, pp. 242–246 (general notice).

PACKARD: Bull. No. 7, U. S. Ent. Commis., 1881, p. 88 (quotes Fitch); 5th Rept. U. S. Ent. Comm., 1890, p. 342 (on butternut).

VAN DUZEE: in Canad. Entomol., xxi, 1889, p. 8 (on blueberry in Canada).

OSBORN: in Proc. Iowa Acad. Sci., i, 1892, p. 127 (in Iowa).

SOUTHWICK: in Science, xix, 1892, p. 318 (mention).

The Insect on Linden.

Leaves of the linden tree, *Tilia Americana,* were received June 22d, 1891, from Mr. D. J. Garth, of Scarsdale, N. Y., having on their stems large masses of the "cuckoo-spit," from which the small ivory-white larvæ which had produced it, had crept out and were actively traveling over the leaves and the box in which they were inclosed. Mr. Garth wrote:

> I have a large Linden growing on my lawn, which has on the stems of the leaves where they join the branches, a substance that looks like the white of an egg beaten to a froth, and small insects within it like those that I send you for examination and report. I have never seen this before, and as it appears to cover the entire tree, I fear that damage may result from it.

Its Habits and Injuries.

Mr. Garth was informed that the examples sent were the larvæ of one of the tree-hoppers, or "spittle insects" as commonly known, which feed on the juices of the trees that they infest, sometimes injuriously, and that the froth-like substance in which they were hidden, was a protective excretion from them, thrown out after the manner, and for the purpose stated in the *Fifth Report Insects New York*, 1889, in the account of the "Alder Spittle-Insect," p. 242. As they were apparently nearly full-grown, and, probably, not excessively abundant, the injury that they would inflict upon the tree through sucking its sap, would not be sufficiently severe to render necessary a resort to means for their destruction.

Change to the Perfect Stage.

A few days thereafter, on June 26th, the perfect winged forms were disclosed, showing them to be *Clastoptera obtusa* (Say), and therefore identical with the Alder insect, to the history of which reference is above made. Its development was unexpectedly rapid, for when received on the 23d, no pupæ were observed, and only four days thereafter the perfect insect was found in the box, so fully colored that it must have emerged from the pupal case the previous day. The insect is shown in Figure 11.

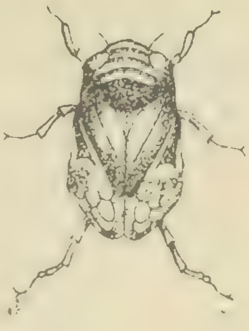

FIG. 11 — The obtuse Clastoptera, C. OBTUSA. (Original.)

Food-plants.

Those that were observed in 1889 (see *loc. cit.*) occurred on the alder, *Alnus serrulata*, upon which it had been reported as common by Mr. Uhler.

Dr. Fitch includes it, in his 3d Report, among the Insects of the Butternut, adding, that it may frequently be met with on quite a number of different trees and shrubs, from the middle of July till the end of the season.

Dr. Packard, in his *Insects Injurious to Forest and Shade Trees*, names it, on the authority of Dr. Fitch, among the Insects of the Butternut, but without mentioning its occurrence on any other tree.

Mr. E. P. Van Duzee, in his *Hemiptera from Muskoka Lake District*, Canada, gives it as very common on the blueberry, in company with *Clastoptera Proteus*, during the latter part of July, 1888.

There seems to be no previous record of its observation on the linden.

Distribution.

It apparently extends over a large portion of the United States and Canada. Say, in his original description, gives it as inhabiting "the United States." It was found by him in the Northwest near Council Bluffs. Provancher gives it as very common in Canada. Uhler states that it is found in many parts of the Eastern United States and in Texas, and extends also to Tamaulipas, Mexico.

Clastoptera pini Fitch.

The Pine Clastoptera.

(Ord. HEMIPTERA: Subord. HOMOPTERA: Fam. CERCOPIDÆ.)

FITCH: in 4th Ann. Rept. [N. Y.] St. Cab. N. H., 1851, p. 53; in Trans. N. Y. St. Agricul. Soc. for 1857, xvii, p. 738; 4th Rept. Ins. N. Y. (in 3d-5th Repts.), 1859, p. 52, No. 259.

Packard: Bull. No. 7, U. S. Ent. Commis., 1881, p. 216 (quotes Fitch); in 5th Rept. U. S. Ent. Commis., 1890, p. 802, f. 272 (quotes Fitch).

Provancher: Pet. Faun. Ent. Canada, iii,—Hemipt., 1886, p. 260 (?var. of *C. Proteus*).

From Miss A. H. Wolsey, of Matteawan, Dutchess Co., N. Y., were received, June 1st, larvæ of a leaf-hopper, enveloped in frothy masses among the terminal tips of pine, which are quite well represented by the figures of the above-named species, in the *Fifth Report of the U. S. Entomological Commission*, by Dr. Packard, at page 802.

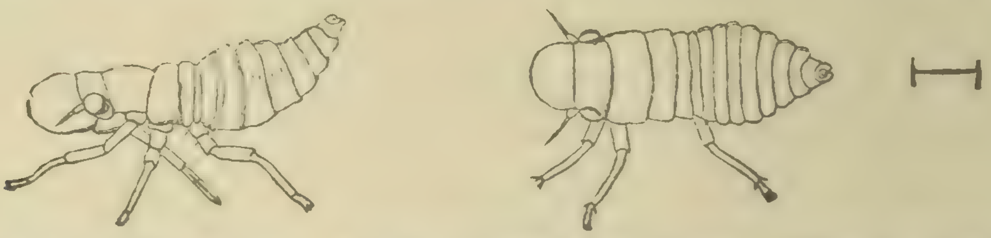

Fig. 12. Larva of Clastoptera on pine — side and dorsal views. (From Packard.)

The Insect Described.

Dr. Fitch characterizes the insect, in his 4th Report, as follows :

Puncturing the leaves [of pine] and sucking their juices, in July, a small, shining, broad, oval tree-hopper, 0.14 long, of a black color, its head pale yellow with a black band on its anterior margin, its thorax prettily sculptured with fine transverse lines and with a pale yellow band anteriorly, its wing-covers with a broad, hyaline, white margin on the outer side, interrupted with black back of the middle, and having a shining black dot near the tip, its under side and legs pale yellow.

The Larva.

The larvæ received by me presented the following features : The head and its appendages, thorax (except the white, sharp lateral margin of the prothorax), terminal segment, ventral mesial plates, and legs (except at the joints, which are white) are glossy black. The abdomen above and laterally is flesh-colored, with a tinge of red on the back and on the sides.

A larva observed traveling about in the box containing the twigs, on June 4th, had the abdomen wholly black.

The Larvæ Observed on Pines.

Miss Wolsey accompanied her sending with the following note relating to the insects:

On the pines this spring I find on hundreds of young twigs a frothy, sappy exudation. Wiping this away, a nimble crawling insect is found, or two insects together, new to me. They are a quarter of an inch long, with a small, shining black head and shoulders, and three pairs of jointed, slender black legs. The body behind is broad, flattened, flesh color, sometimes brick red, and ringed and horny in substance. It seems like an insect in transition somewhat. The exuded sap is evidently its work. It is very active, and may be one cause of the death of terminal twigs and branchlets occurring late in the season.

Miss Wolsey was requested to search the pines early in June for the mature insect, the features of which were given, that positive identification might be made of the larvæ. Heavy rains had meantime occurred, and it was thought that they may have destroyed the insect in its immature stages or driven away the imagoes.

Chauliodes pectinicornis (Linn.).

The Comb-horned Fish-fly.

(Order Neuroptera: Fam. Sialidæ.)

Hemerobius pectinicornis Linn.: Amoen. Acad., vi, 1763, p. 412; Syst. Nat.. i, pars ii, xii edit., 1767, p. 911.1.

Hemerobius pectinicornis Fabr.: Syst. Ent., 1775, p. 309.1.

Semblis pectinicornis Fabr.: Spec. Ins., 1781, i, p 386.1.

Sembris pectinicornis Fabr.: Mant. Ins., i, 1787, p. 244.1.

Chauliodes pectinicornis Latr.: Gen. Crust. Ins., iii, 1807, p. 198.

Hagen: Synop. Neurop. N. A., 1862, p. 189 (descrip. imago and distribution); in Proc. Ent. Soc. Phila., ii, 1863, p. 181 (mention ; in Proc. Bost. Soc. Nat. Hist., xv, 1873, p. 29 (in Harris Collection).

Walsh-Riley: in Amer. Ent., i, 1869, p. 245 (characters of imago).

Packard: Guide Study Ins., 1869, p. 607; Entomol. Begin., 1888, p. 87 (mention).

Pettit: in Canad. Entomol., vi, 1874, p. 45 (in Canada).

Moody: in Psyche, ii, 1877, p. 52 (description and habits of larva).

Riley: in Canad. Ent., xi, 1879, pp. 97, 98; in Proc. Amer. Assoc. Adv. Sc. for 1878, July 1879. xxvii, pp. 286, 287 (eggs and features of Chauliodes larvæ, incl. this species?).

Comstock: Introduc. Entomol., 1888, p. 220 (mention).

Banks: in Trans. Amer. Ent. Soc., xix, 1892, p. 357 (cited).

The illustrations of Plate 1, from drawings made by Mr. J. Bridgham, are from a larva of the above-named insect, which was received from Mr. W. C. Hitchcock, of Tiashoke, N. Y. It had been taken from a pond in that vicinity early in March, from a hole cut in the ice. It was the only specimen of the kind observed, and none others could be found, although search was made for them in compliance with a request for additional examples for rearing.

Literature.

But little has been published of this insect, and no figure had been presented of its early stages. Dr. Hagen, in his *Synopsis of the Neuroptera of North America*, in 1862, states: "The larva is unknown; perhaps it is aquatic."

The following year, 1863, Mr. Walsh described* the larva of a nearly allied species, *Chauliodes rastricornis* Ramb., frequently found in the Southern States, and probably in Missouri, as Mr. Walsh had "bred many specimens of the insect from the larva, which occurs under the loose bark of floating logs, apparently beneath the surface of the water, and retires under logs, etc., on the dry land to assume the pupa state, forming a rude cell there, as does *Corydalis cornuta* (Linn.)." The same species has recently been described and figured in its different stages by Prof. C. M. Weed, from examples taken from under logs lying under water in ponds in Ohio:† the figures, through permission of the Ohio Agricultural Experiment Station are herewith given.

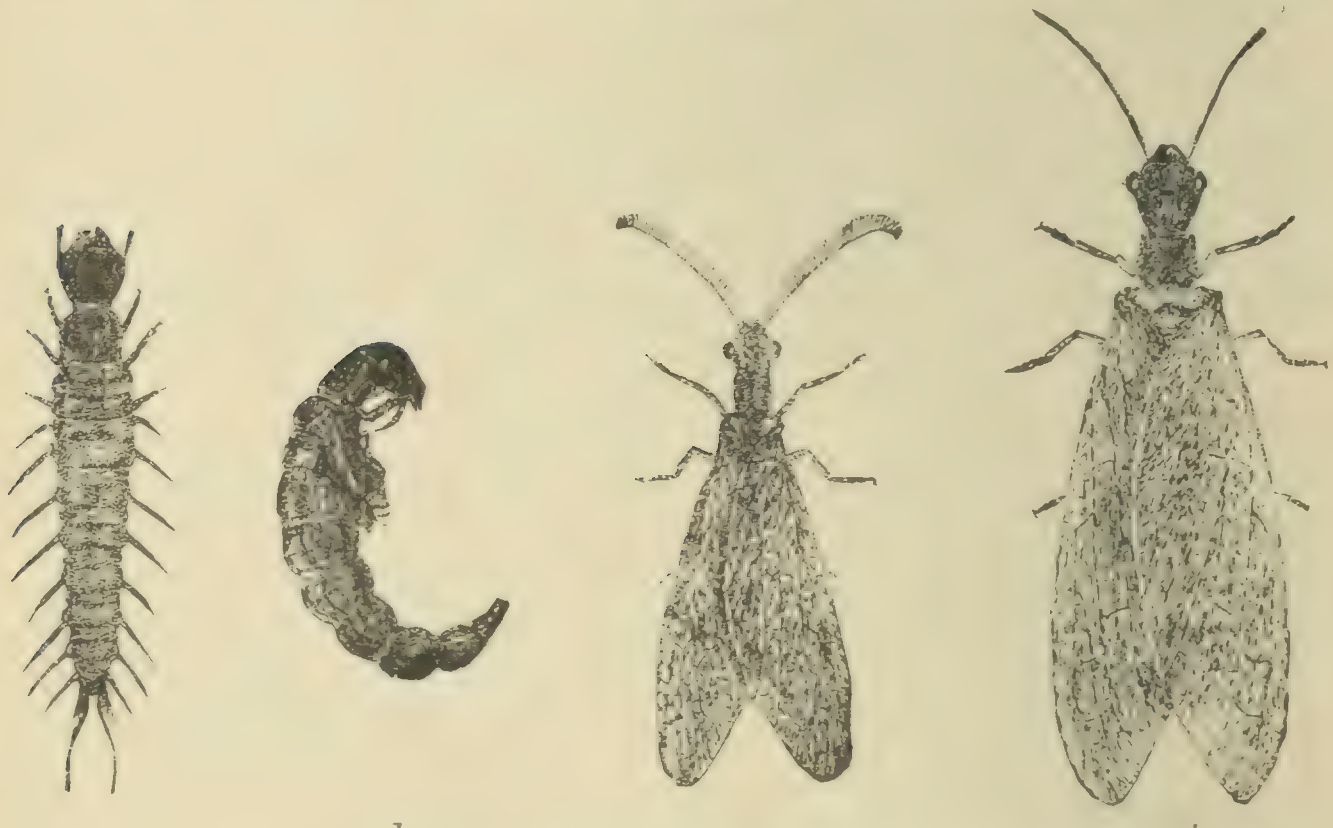

FIG. 13.— CHAULIODES RASTRICORNIS: *a*, larva; *b*, pupa; *c*, male imago; *d*, female imago — all in natural size. (After Weed.)

The Canadian Entomologist for May, 1879, contains an abstract of a paper read by Professor Riley before the American Association for the Advancement of Science (the entire paper has not been published), entitled: "Larval Characteristics of Corydalus and Chauliodes." In this abstract some of the larval features of *Chauliodes* are given, and

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* *Proceedings of the Entomological Society of Philadelphia*, ii, 1863, p. 263.

† *Bulletin of the Ohio Agricultural Exper. Station.* Technical Series, vol. 1, No. 1, October 1889, pp. 7-10, pl. 1, fig. 3.

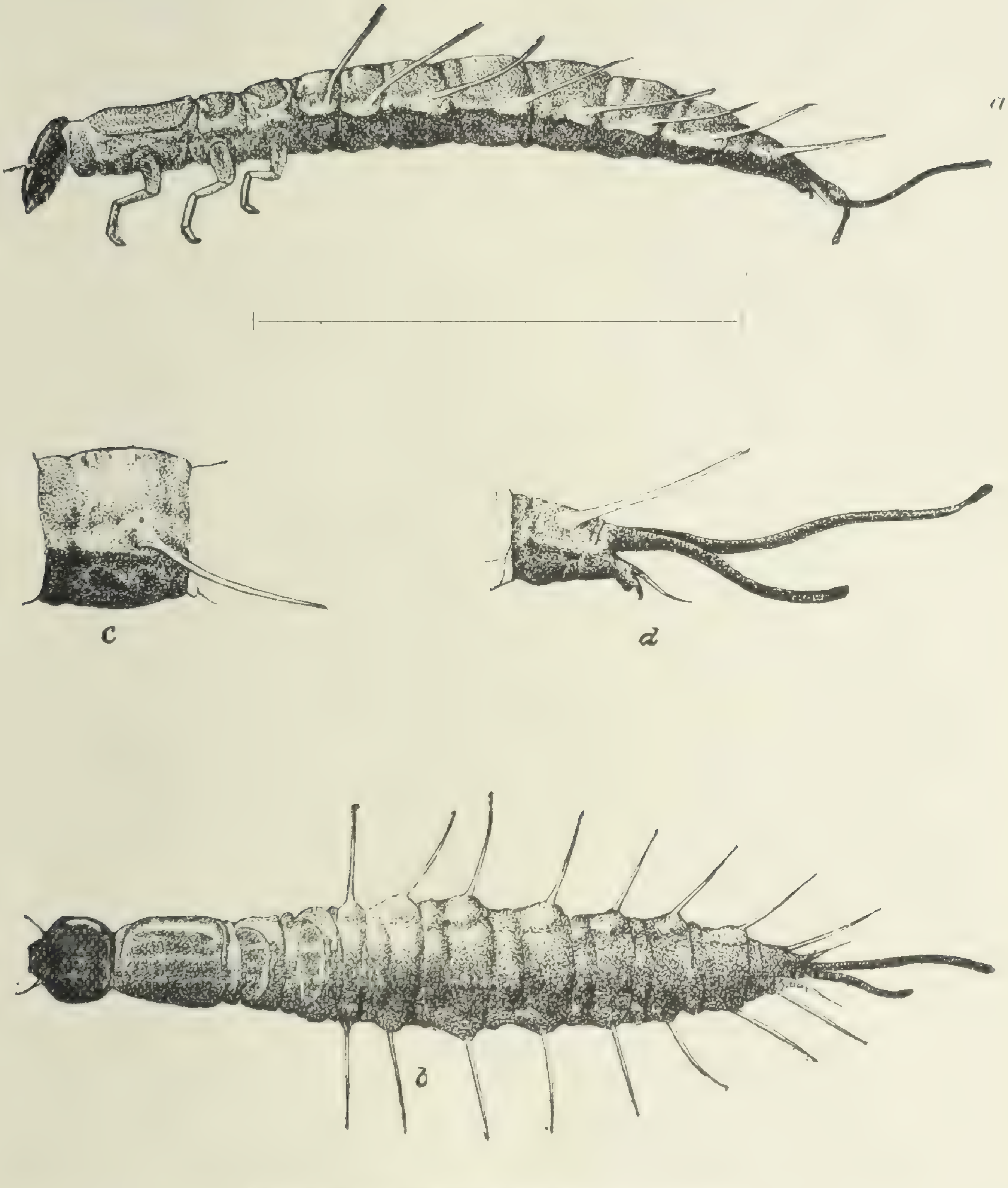

PLATE 1.—Larva of CHAULIODES PECTINICORNIS: *a*, side view; *b*, dorsal view; *c*, an abdominal segment more enlarged; *d*, anal segment with appendages similarly enlarged. (Original.)

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errors made by Mr. Walsh, in his description, noticed. Professor Riley was probably acquainted with the *C. pectinicornis* larva at the time of the above publication.

The Larva of Chauliodes pectinicornis.

Very little has been written of this insect. All the notices that I have been able to find of it are cited in the bibliography on the preceding page. The account given of it by Henry L. Moody in *Psyche*, *loc. cit.*, seems to embrace all of what has been published of it. Mr. Moody found a larva on October 21st in a cavity in moist sand under a stone, nearly ready for pupation. It changed to a pupa two days thereafter, and in twelve days more to the perfect stage.

Of another example subsequently taken, and believed to have been of the same species, which it probably was, as *C. rastricornis* rarely occurs in New England, Mr. Moody has given the following particulars:

Its movements in the water, other than by walking, are always backward, and are performed by a downward and forward sweep of the tail. It could move rapidly, but at times would drift lazily about near the surface of the water. It ate houseflies if they were held before it by a foreceps so that they could be seized without first touching the larva.

"It was thirty-five mm. long, rather slender, narrowing moderately from the middle of the body to the head, and more strongly in the opposite direction to a narrow final segment. The head is large and prominent, the body moderately flattened and somewhat appressed. The mandibles are rather large and strong, nearly straight and strongly toothed on the inner edge at the tip. The mandibles are usually widely extended when the larva is walking at the bottom of the vessel. On each side of each segment after the thoracic ones there is a slender whitish filament, which is a little longer than the body is wide at its widest part. From the posterior edge of the terminal segment there arise two filaments, contiguous at their base, long, blackish, very contractile and rather thicker than those of the sides. These filaments are undoubtedly respiratory organs, and are usually directed upwards, so that their tips reach the surface of the water. There is a long, stout bifurcated proleg just beneath these filaments. The color of the head is chestnut-brown; that of the body rather light brown, with a black, interrupted medio-dorsal line, and on each side a much narrower and more obscure similar line. The legs are rather stout, of moderate length and honey yellow."

Habits of Chauliodes.

The brief pupal stage noted above by Mr. Moody of *C. pectinicornis* (twelve days) is also a feature of *C. rastricornis* as observed by Mr. Weed — in one instance, fourteen days, and in another the very short period of eight days. Of this last-named species, the following habits are recorded by Mr. Weed in the article cited, which probably are identical with those which would be displayed by *C. pectinicornis:*

> Their ordinary mode of locomotion is by crawling along weeds and the debris of various kinds which gathers at the bottom of ponds, but when alarmed they can swim rapidly by suddenly doubling the body up, bringing the head in contact with the abdomen, by which means they are propelled some distance through the water. They evidently live upon various animals, as I have seen them feeding on dead back-swimmers (*Notonecta undulata*), flies which had fallen into the aquarium, and in one case a spider which I had thrown in. When a Notonecta or Zaitha would come near the Chauliodes while feeding, the latter would snap viciously at it with its powerful jaws. * * * When handled, the Chauliodes larvæ occasionally eject from the mouth a considerable quantity of a blackish fluid, reminding one of a similar habit of certain locusts (*Acrididæ*). These larvæ have also a peculiar habit of walking on the surface of the water, body downward. They can move along in this manner quite rapidly.

C. rastricornis was for a long time thought to be confined to the Southern States, but it appears to be not an uncommon species in Ohio, as Prof. Weed records the capture of at least a dozen species in the year 1889, in that State. Mr. Samuel Henshaw has taken the insect in June, presumably in Boston or its vicinity, and Dr. Hagen has received it from Milton, Mass., and also from Illinois.

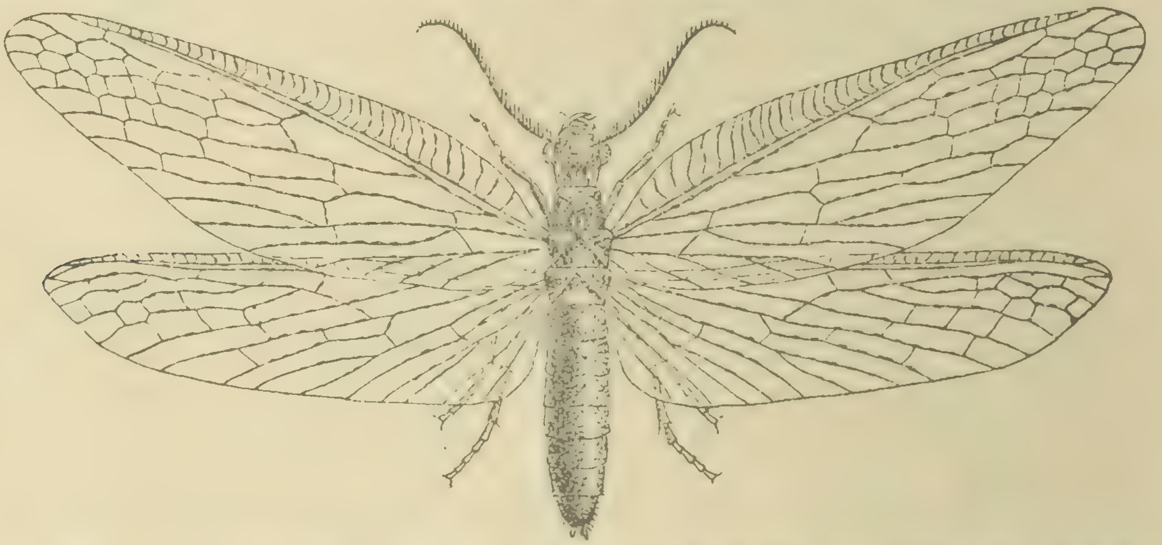

Fig. 15 — The comb-horned fish-fly, Chauliodes pectinicornis, in natural size (original).

The Winged Insect.

In its perfect stage, *Chauliodes pectinicornis* resembles in general appearance the horned Corydalis, *C. cornuta*— a much more common insect, and with which most persons are more familiar. Its more striking differences are a smaller size, a less robust build, the wingt not so strongly veined, its mandibles much shorter and projecting bus little beyond the front of the head, the antennæ with long pectinations like the teeth of a comb, in both sexes, the front wings without the small round white spots within the cells, seen in Corydalis, and with the brown veins interrupted with white.

It is a rather common insect in localities favorable for it in the State of New York, it having been frequently taken by me at Schenectady, on the Mohawk river, in the months of June and July, and extending into August, where, also, *Chauliodes serricornis* Say, was not rare in the month of June, while *C. rastricornis* has not occurred with me, in New York. Examples of *C. pectinicornis* in the Harris collection, and now in the collection of the Boston Society of Natural History, according to Dr. Hagen (*loc. cit.*), bear the following dates of capture: July and August, 1821; May 25, 1827; June 10, 1827; September 20, 1829; N. Carolina; June, New York, Calverley.

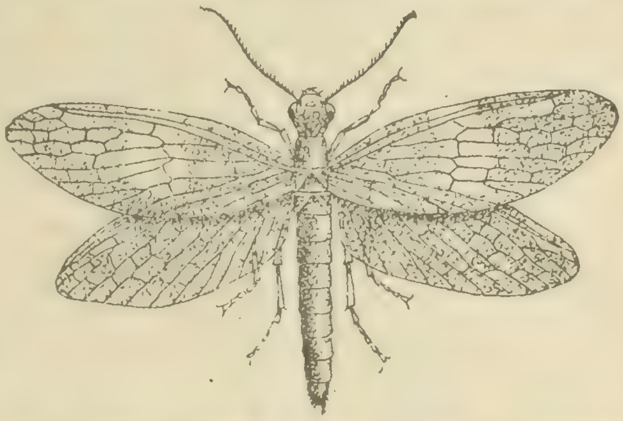

Fig 16.—The saw-horned fish-fly, Chauliodes serricornis, in natural size (original).

Not an Injurious Insect.

While of a carnivorous habit, the food of the larva, for the most part taken from the bottom of the waters which it inhabits, would naturally consist of both injurious and beneficial forms, perhaps about equally divided. It has been suggested that with a seeming preference for a pond life, it might become injurious should it ever abound in fish ponds, from feeding on the eggs of fishes and the young fry; but knowing the fondness of the bass and several other fishes for the horned corydalis — the "dobson,"— there need be no fear that this weaker and less formidable looking creature would ever be permitted to become injuriously abundant in any water where desirable fish-food is not in excess.

Corydalis cornuta (Linn.).

The Horned Corydalis.

(Ord. Neuroptera: Fam. Sialidæ.)

Linnæus: Syst. Nat., i, pars ii, xii edit., 1767, p. 916.3 (*Raphidia*).

Fabricius: Sp. Ins., i, 1781, p. 392.1; Mant. Ins., i, 1787, p. 246.1; Ent. Syst., ii, 1793, p. 81.1 (*Hemerobius*).

Latreille: Gen. Crust. Ins., iii, ?1809, p. 199.1 (*Corydalis*).

Haldeman: in Mem. Acad. Arts-Sci., Jan., 1850, pp. 162–168, pl. 1–3 (transformations).

Hagen: Synop. Neurop. N. A., 1861, p. 192 (bibliography and description); in Proc. Ent. Soc. Phila., ii, 1863, p. 181 (respiration and habits).

Walsh: in Proc. Ent. Soc. Phila., ii, 1863, p, 265 (traveling habits of larva and transformations); in Pract. Entomol., i, 1866, p. 113 (habits); in *id.*, ii, 1867, p. 107 (horns of the male).

Walsh-Riley: in Amer. Entomol., i, 1867, pp. 61, 62, f. 56 (general account).

Packard: in Amer. Nat., i, 1867, p. 436, figs. 1, 2 (description of larva and imago); Guide Study Ins., 1869, p. 607, f. 594 (female); in 3d Rept. U. S. Ent. Commis., 1883; pp. 335–338, pl. lii, figs. 1–3 (structural characters); Entomol. Begin., 1888, p. 87, figs. 74–76 (mention); in Psyche, v, 1889, p. 224 (epipharynx).

Saunders: in 3d Rept. Ent. Soc. Ont., for 1872, 1873, pp. 56–58, figs. 47, 48, not 49; the same in Canad. Entomol., vii, 1875, pp. 64–67, figs. 9, 10 (natural history).

Riley: 5th Rept. Ins. Mo., 1873, pp. 142-145, figs. 69, 71 (general account); in Scientif. Amer., l, 1873, pp. 392, 393 (habits, figures of stages, etc.); 9th Rept. Ins. Mo., 1877, pp. 125–129, figs. 30, 31 (early stages); in Proc. Amer. Assoc. Adv. Sci. for 1876, xxv, 1877, pp. 275–279 (eggs); in *id.* for 1878, xxvii, 1879, pp. 285–287 (eggs, larva, imago, respiration, etc.); in Canad. Entomol., xi, 1879, pp. 96–98 (larval characteristics). Prec. as *Corydalus cornutus.*

Barnard: in Amer. Entomol., iii, 1880, p. 178 (as *Corydalus* — eggs).

Krauss: in Psyche, iv, 1884, pp. 179–184, pl. 2 (as *Corydalus* — nervous system of larval head).

Fyles: in 15th Rept. Ent. Soc. Ont., 1885, pp. 46–48, figs. 6, 7 (transformations).

Comstock: Introduc. Entomol., 1888, pp. 219–221, figs. 190, 191 (eggs, larva, and transformations).

Lintner: 7th Rept. Ins. N. Y., 1891, p. 254 (the larva a traveler).

Banks: in Synop. Cat. Bib. Neurop. N. A., in Trans. Am. Ent. Soc., xix, 1892, p. 357.

This insect has been mentioned in my reports, but it has received no extended notice, although inquiries have frequently been made of it by letter and in person. Personal inquiries have uniformly been met by presenting the excellent figures and account given by Professor Riley in the *American Entomologist*, for December, 1868. The figures of that article are herewith given from electrotypes obtained from Professor Riley. For another paper upon the insect from the same author, but essentially the same, the reader, may refer, if more convenient, to the Fifth Missouri Report. It may be noted here that in each of these the eggs of the insect are erroneously figured, as was subsequently learned, and for their correct representation and description, the Ninth Missouri Report may be seen, where, also, the young larva is for the first time described and figured.

References to other writings on this insect are given in the above bibliography, and as some of them, at least, may be conveniently referred to by those who would like to know more of its interesting habits and transformations, it is thought not desirable to embody them in a general account for the present report.

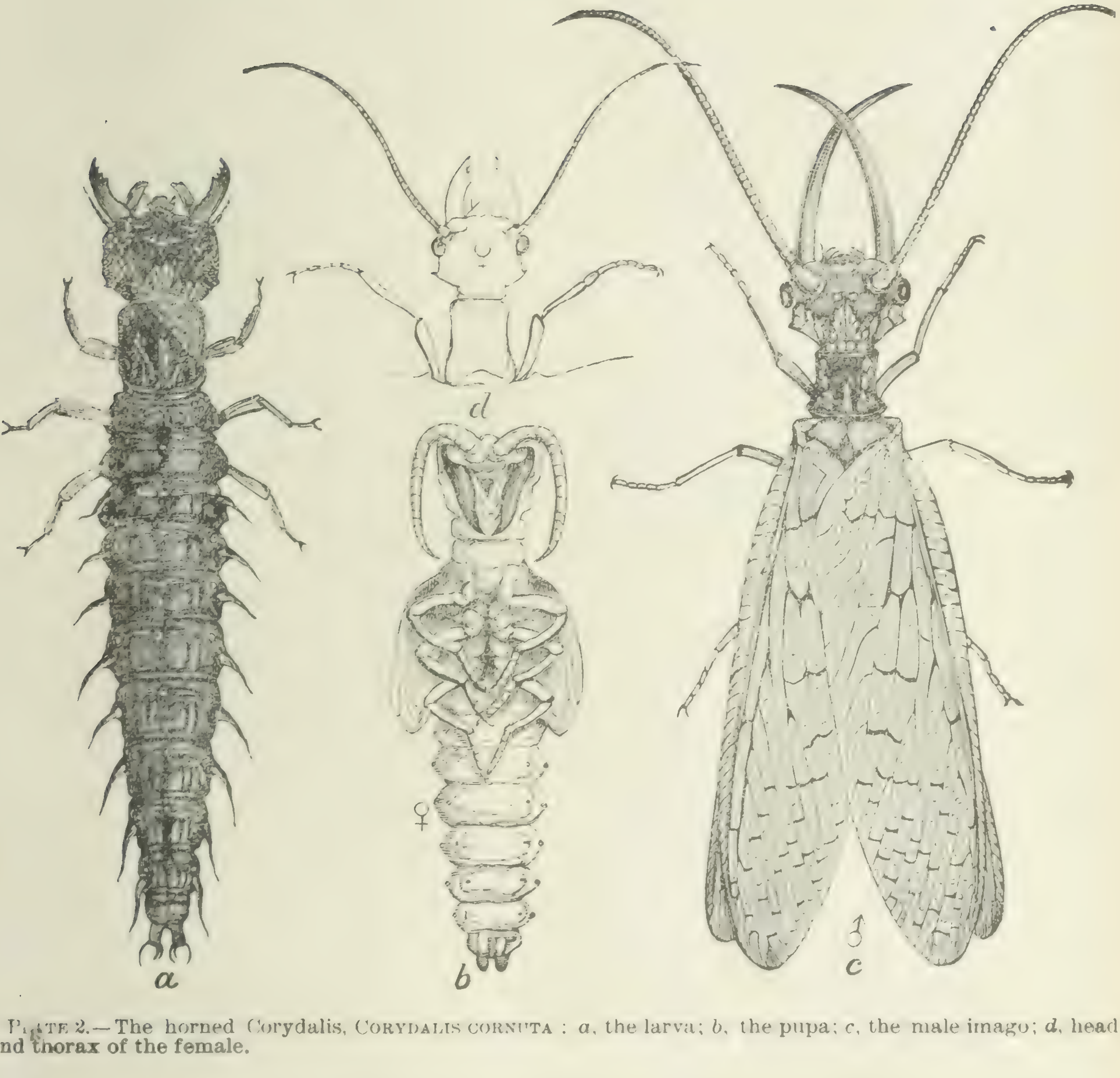

Plate 2.—The horned Corydalis, CORYDALIS CORNUTA: *a*, the larva; *b*, the pupa; *c*, the male imago; *d*, head and thorax of the female.

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The following was sent to a correspondent, Mr. C. L. Shear, in Alcove, N. Y., who wrote July 7th, 1891:

> Will you please give me the name of the inclosed insect, and tell me whether it is common or not; also whether there is any notice of it in your reports. The specimen is somewhat mutilated, owing to the carelessness of the collector, which was a cat.

The insect is the "horned Corydalis," *Corydalis cornuta*, so named from the two long curved mandibles borne by the male. It belongs to the order of Neuroptera, and is allied to the dragon flies — like them, its larvæ living in the water. It is a common species, and is distributed over a large part of the United States. The larvæ are often collected by boys from beneath stones in running streams, and sold to fishermen at a good paying price, as bait, particularly suited to bass — it being, in piscatorial parlance, "the dobson," or "the crawler." They are formidable looking creatures, measuring, when full-grown, about three and one-half inches in length, with a large flattened head provided with unusually long and strong mandibles, three pairs of long legs and two sets on each side of floating lateral appendages which are breathing organs or gills, for its use in the water. It is also provided with the usual number of spiracles or breathing pores, to serve for respiration when it leaves the water for its pupation on the land beneath a stone or log. It is shown in Plate 2 at *a*.

Dr. David Norwood, of Esperance, has given me the following information of its habits, which I find recorded among my notes under date of May 3d, 1869:

> The larva leaves the water earlier than is usually supposed. At the present time they may be found hidden under stones upon the shores of the Schoharie creek. They sometimes occur at a distance of a hundred yards from the stream in adjoining garden plats beneath stones. They are very numerous in this vicinity, and are extensively used for fish-bait. Quarts of them can be taken at any time by the boys, who adopt the following ingenious plan for capturing them: Wading into the creek, with a seive in one hand and a hooked wire in the other, stone after stone is carefully raised with the hook, and from almost every one a larva is swept out by the running water and dexterously captured by the seive placed in position for receiving it. In this manner a bushel could be easily caught if so many were needed.

The above was communicated to the gentleman in reply to his inquiry. The present opportunity is taken to record some observations recently made by me on the habits and respiration of a larva under confinement.

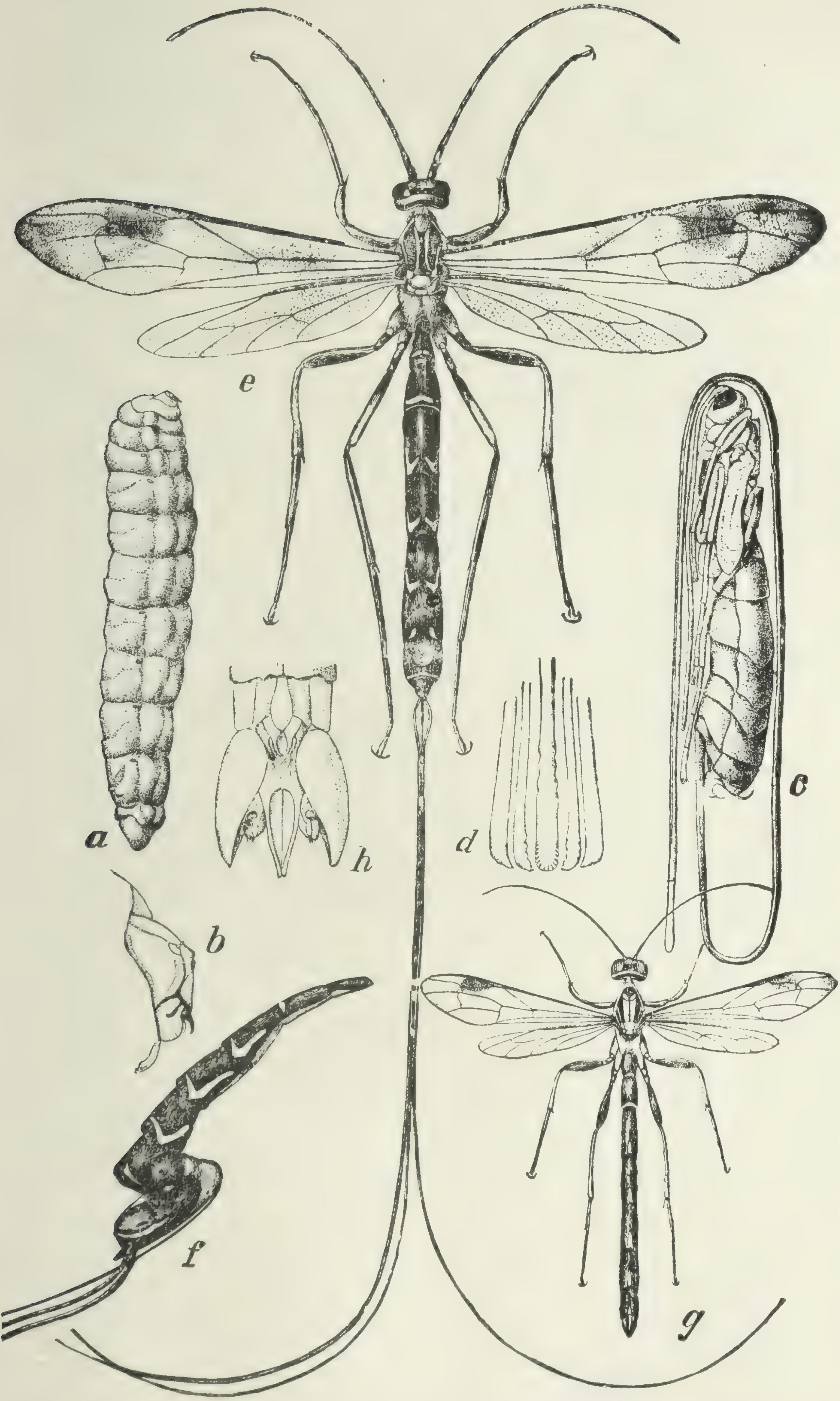
A larva of this species was kept under observation in an aquarium in my office for eight months, during which time it partook of no food, although flies and other insects, and small earth worms were offered it. It underwent no moultings or other changes, and at the expiration of the time stated, it died, apparently from not having partaken of nourishment.

Professor Riley has written (in the *Canadian Entomologist*, as cited) of the respiration of this larva as follows: "In the water a constant motion of the ventral branchial tufts is kept up, the main stem being first moved quickly backward and upward so as to bring the whole tuft close to the body, the filaments of which it is composed being then closely appressed to each other. The main stem is then brought more slowly down in the opposite direction, when the filaments spread and enlarge the whole to its utmost. In pure water the motion occurs about once a second; as the water becomes impure the motion becomes more rapid."

The respiration as observed by me, not long after its reception and therefore before it could have become enfeebled, was far from being continuous,—on the contrary it was remarkably intermittent, without any apparent cause. The following note was made at the time:

The branchial tufts may be, and frequently are, used independently of one another. The first and second pairs on segments four and five are the most frequently used, and sometimes those only on one side are in action. An interval of twelve seconds has been observed, without the slighest branchial motion. Occasionally, the only respiration seen was in the movement of a single branchial tuft. When transferred to fresh water the respiration was increased in rapidity, fifty-two motions having been counted in a minute.

Professor Riley has written: "The motion of the larva is invariably backward." During its confinement in the aquarium, my specimen was often seen to swim in a forward direction, almost completing the circuit of the vessel, and with a facility very nearly equaling that of its ordinary mode of progression.



Marx, del.

PLATE 3.— The lunated long-sting, THALESSA LUNATOR: *a*, larva; *b*, side view of head; *c*, pupa; *d*, tip of pupal ovipositor showing the five parts; *e*, the female; *f*, side view of abdomen; *g*, the male; *h*, anal extremity of male, enlarged.

NOTES ON VARIOUS INSECTS.

Thalessa lunator (Fabr.).

The Lunated Long-sting.

About twenty examples of this insect, males and females, were taken by me during the month of September, from the dead trunk of an elm left standing on a sidewalk in Albany, after its top had been cut off at a height of ten feet from the ground. The bark had been removed from the tree while it was still living for about one-half its circumference and the wood painted to arrest further decay or injury. Early in September my attention was arrested by a quantity of sawdust clinging to the painted portion of the trunk, where, on examination, it was found to be perforated with hundreds of small round holes of a diameter of about one-tenth of an inch; while a still larger quantity of the dust had fallen down and was covering the bark at and near the base. From eight to ten of these holes could be counted, in places, in a square inch of surface. Many of them, judging from their diameter, were the work of the wood-wasp, *Pemphredon concolor* Say, numbers of which were observed upon the trunk, running over it, entering the holes, and emerging from them, during the time above stated. About twenty examples were captured for the State collection.

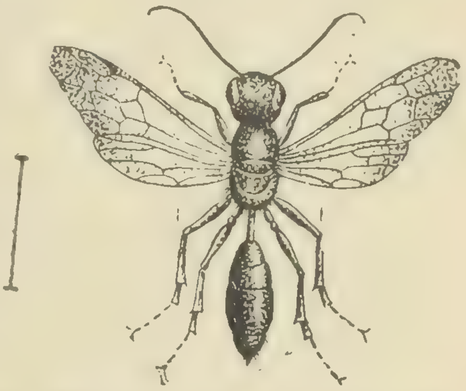


Fig. 18. A wood-wasp, Pemphredon concolor Say (original).

I find nothing written of the habits of either of our two species of Pemphredon (*marginatus* Say, the other). Curtis, in his *Farm Insects* (page 76), says of two English species, *Pemphredon unicolor* Latr., and *P. lugubris* (Fabr.), that they may be seen during the summer months carrying immense quantities of aphides into holes in wood, posts, etc., to feed their young upon.

A single example of *Tremex columba* (Linn.) was taken from the trunk September 16th. The "insects" (which of them could not be definitely stated, but probably "the long-stings,") had been so abundant during the month of August that they had attracted the attention of persons living in the vicinity, and small boys, it was reported, had been amusing themselves by catching and killing them.

The Thalessas were only seen upon the bark. The males were apparently awaiting the emergence of the females from the can be readily known by its antennæ longer than the body, and quittrunk, for if disturbed, they would frequently fly up for a short circuit and then return. The females, rarely seen until the latter part of the afternoon, were always intent on oviposition either getting in readiness to insert the ovipositor, or with it already entered at various depths to a maximum of two inches, and with the abdominal muscular sac aiding in oviposition, distended in different degrees. The wood was apparently solid where the oviposition was occurring, but the bark had been perforated as numerously by the wood-wasps as had been the decorticated portion. That the wood was at least comparatively solid was shown by the firmness with which the ovipositor clung to it. In an attempt to remove an example, while holding it by the thorax and abdomen, the body was torn in two near its terminal end. But by seizing the ovipositor between the thumb and finger and pulling it steadily but gently, it could invariably be withdrawn entire in from fifteen to twenty seconds of time.

The tree was passed daily in my walks to and from my office. The Thalessas were observed for the last time on September 18th and the Pemphredons on September 22d.

In the notice of *Thalessa lunator* in my Fourth Report, the question was asked: "Does Thalessa oviposit in exposed larvæ?" An oviposition of a large Ichneumonidan in a colony of a *Datana* on a hickory tree, observed by me about the year 1860, was described and referred, from memory, to *Thalessa lunator*. In Dr. Riley's admirable paper on "The Habits of Thalessa and Tremex," on pages 168-179 of *Insect Life* for December, 1888, in replying to the above query, he has endeavored to show that this method of oviposition was impossible to Thalessa, and suggested that my memory of the species that I had seen thus engaged must have been at fault,—some other large Ichneumon having been mistaken for Thalessa. That Dr. Riley is correct in this opinion finds strong support in a notice entitled "Oviposition of Anomalon sp.," by Prof. C. P. Gillette, in *Entomological News*, i, 1890, p. 130, in which is related the oviposition of a large black Anomalon species, in a colony of *Datana ministra*, in a manner and with all the attendant circumstances identical with the operations as described by me.

In the *Journal of the New York Microscopical Society*, for October, 1891, page 135, Rev. J. L. Zabriskie gives an interesting account of the very serious results attending a wound said to have been inflicted by one of the "long stings" on the arm near the wrist of a robust, healthy laboring man. "For four or five days intense pain, and great swelling involving the entire arm, the axilla and a portion of the side of the body, gave symptoms of a severe case of erysipelas."

In my Fourth Report, a figure is given on page 39 of a Thalessa in the act of ovipositing, taken from some old cut, which, under the supposition that it was intended to represent *T. lunator*, was so designated by me. Dr. Riley, in *Insect Life*, i, p. 173, has copied from the *American Agriculturist*, a figure almost identical with this, which he refers to *Rhyssa persuasoria* (Linn.) —an European species, having a shorter ovipositor than ours, and with other differential features that have given it place in another genus. In correction of my error, the figure of my Fourth Report is herewith given with its corrected name, and in Plate 2 [Figure 17], I also present the excellent plate of *Thalessa lunator* which was one of the illustrations of Dr. Riley's paper previously referred to.

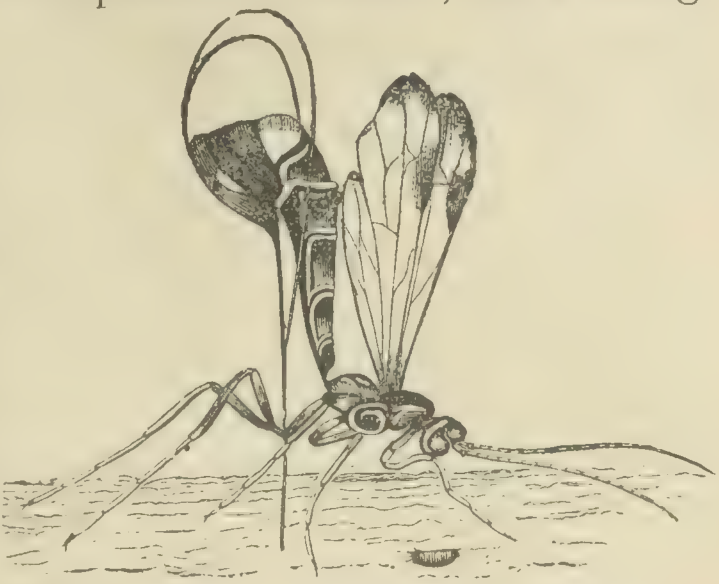


Fig. 20 — The long-sting. Rhyssa persuasoria, female, ovipositing.

The illustration of *Tremex Columba*, in its larval, pupal and perfect stages, from the same paper is also given herewith, as being a great improvement upon the representations hitherto published of this species, and as illustrating the parasitic association with it of *T. lunator*.

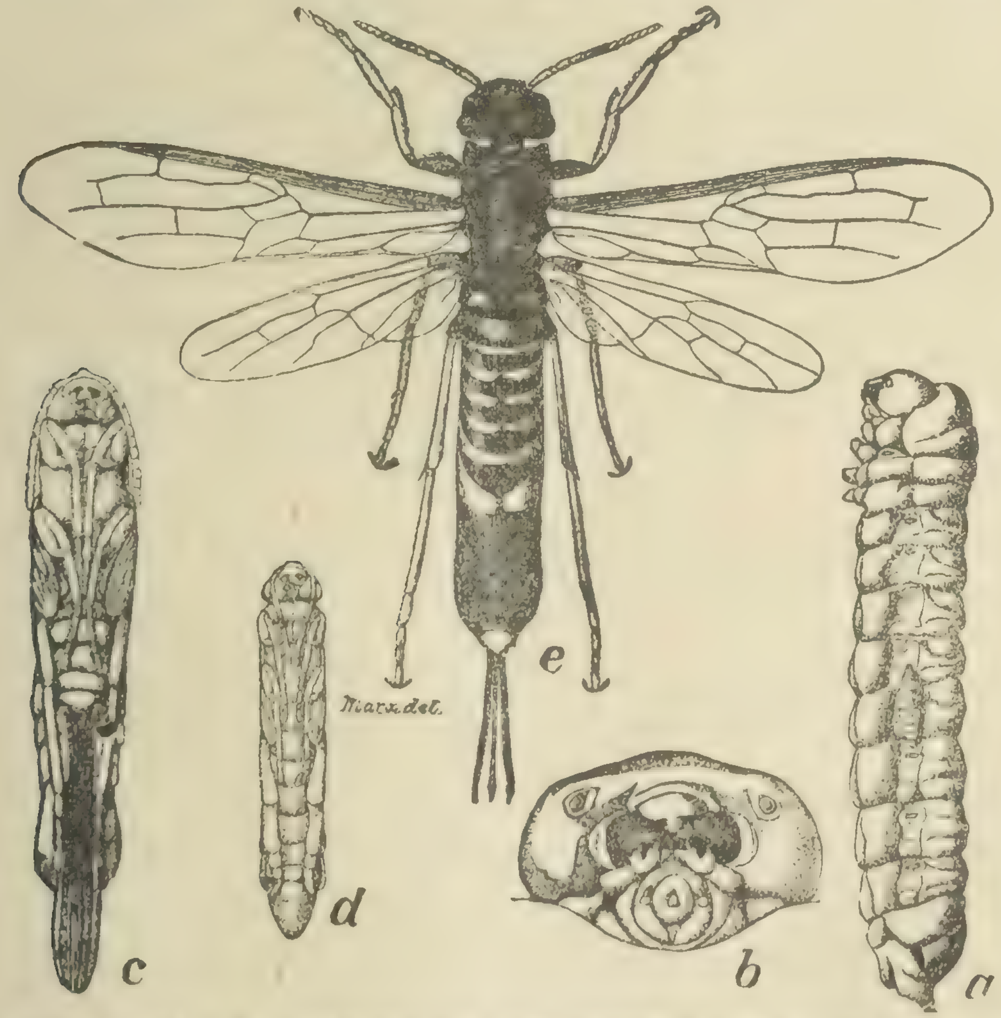


Fig. 21 — Tremex Columba: *a*, larva showing the Thalessa larva fastened to its side; *b*, head of larva; *c*, pupa of female; *d*, male pupa; *e*, adult female — all slightly enlarged.

Provancher, in his *Faune Hyménoptérologique de la Province de Quebec*, names *Rhyssa persuasoria* as found in Canada; and Mr. W. H. Harrington in the 21st *Annual Report of the Entomological Society of Ontario*, 1891, states of it: "I have not recognized this species at Ottawa yet, but have a male apparently belonging to it from Rev. G. W. Taylor, of Victoria, B. C."

? **Janus flaviventris** Fitch.

The Currant-stem Girdler.

Of the operations of this insect, which was noticed in the *Fourth Report on the Insects of New York*, page 47, and which, up to the present we have not been able to refer, positively, to any known currant pest, Mr. J. F. Rose, of South Byron, N. Y., has written, under date of June 6, 1891, as follows:

> I inclose specimens of a few currant stems which show the work of an insect which cuts them off so that about two or three inches of the young growth breaks over. A few years ago I was badly tormented with currant borers, and, on marking several shoots in June that were injured in this way, found that each of them in the spring had a borer. Since that time it has been my habit to go over the currants several times, cutting off these shoots about one inch below the injury and burning the injured tips. I now find very few borers. Am I right in thinking that the saw-fly, or whatever it is that does the cutting, is the egg-inserter that makes the currant stalk-borer?

Replying to Mr. Rose, he was informed of the puzzle that this girdler had been, and request was made that he mark some of the punctured stems, and send them in the early spring for examination for the pupa or matured insect, that the insect causing the injury might be identified. Its operations were seen by me on the grounds of Mr. George T. Powell, at Ghent, N. Y., on June 8th of the present year, in his extensive plantation of Fay's Prolific currant, but only in a few examples.

A dissection of two of the punctured twigs received from Mr. Rose disclosed the egg within the stem, at about a half-inch in each instance below the puncture. It was white, transparent, rounded at the ends, one-twentieth of an inch in length and half as broad.

The following, taken from *Insect Life*, iii, 1891, p. 407, may prove to be the recognition and identification of the "currant-stem girdler," above referred to:

> I send you by this mail one male parent of a native Hymenopterous currant worm, the same as was noted a year or two ago by Professor Lintner, in his Fourth New York Report. I first bred one pair in 1887 from larvæ grown in 1886, and this was raised in 1888–'89. The springs of 1888 and 1890 I was not able to find any. Please report name, etc.—[E. W. Allis, Adrian, Michigan, December 3, 1890.]

Reply.—This insect is without doubt *Janus flaviventris* Fitch; see Fitch's seventh report, species No. 12. This discovery of yours is a very interesting one, if the insect works in the way described by Lintner in his fourth report, page 47.—[December 5, 1890.]

On turning to Dr. Fitch's Seventh Report (page 165 of the Sixth–Ninth Reports, 1865), we find, as Nos. 12 and 13, *Janus flaviventris*, n. sp., and *Phyllœcus trimaculatus* Say, followed by: "In rye fields toward harvest time, scattering heads of the grain remaining erect and having a prematurely ripe appearance, the straw bored its whole length by a footless worm a half-inch long." In the text following, Dr. Fitch questions whether this may be the work of some species of *Chlorops*, or of some saw-fly nearly related to the *Cephus pygmeus* of Europe [since found in the State of New York]. He then adds: "A New York insect of this kind, the same in size with the European species, and coming abroad like it the last of May, has the hind body cylindrical instead of being compressed, and consequently pertains to the genus *Janus*."

Dr. Fitch's description of the species is herewith given, that it may be seen hereafter if it be the one that may be bred from the girdled currant stems. The girdling operation would be anomalous in the *Cephidæ*.

It is a pretty little fly of a shining black color, with its hind body lemon-yellow except at its base, its mouth being straw-colored, and also the hind margin of its collar, the base of its wings, a small black spot above its sockets, and the fore and hind margins of the metathorax. The hind body is more narrow than the fore body, and more narrow and long than in the typical species of this genus, forming almost two-thirds of the total length of the insect. Its basal segment is black, edged anteriorly with straw-yellow, and with a slender line of this color along its middle, ending in a large triangular spot. The second segment is also black except at its hind end; and on the sides is a blackish cloud on the surface of each of the remaining segments. The wings are hyaline and glossy, their stigma sooty brown, which color extends inward, occupying most of the anterior marginal cell. A faint smoky cloud may also be perceived near the middle of the posterior apical cell, and another along the margin of the anterior one. The hind feet are dusky.

Janus is a genus of the *Uroceridæ*, allied to *Cephus*. *J. flaviventris* Fitch is the only species recorded in this country. Mr. Edward Norton has included it in his "Catalogue of the Tenthredinidæ and Uroceridæ of North America," in 1867, in the last-named family, but had not seen the species.* Mr. E. T. Cresson, in his later Catalogue (1880) of the same families, includes it among the *Tenthredinidæ*, and in his more recent "Synopsis of the Hymenoptera of North America," in the *Uroceridæ* (page 172).

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*In *Transactions of the American Entomological Society*, ii, 1869, p. 344 (quotes Fitch's description).

From perhaps a dozen of the burrowed twigs subsequently sent to me by Mr. Rose in the spring after the girdling had been marked in the preceding spring, a single example of the perfect insect was obtained. It had become moldy and was set aside for cleaning, after an unsatisfactory comparison with the Fitch description had been made, which seemed to indicate a different species. Unfortunately the specimen has been mislaid and can not now be found.

Nematus Erichsonii Hartig.

The Larch Saw-fly.

This insect is still continuing its ravages in the Adirondack Mountains. On August 7, 1891, many of the larches observed from the road in passing from the Wilmington Notch to the Mountain View House in North Elba, in Essex county, were seen to be nearly or entirely stripped of their leaves. Quite a number of dead larches were noticed which it was thought had been killed by their annual defoliation for a few years past—the attack having been observed by me in the Lake Placid region in the summer of 1888.

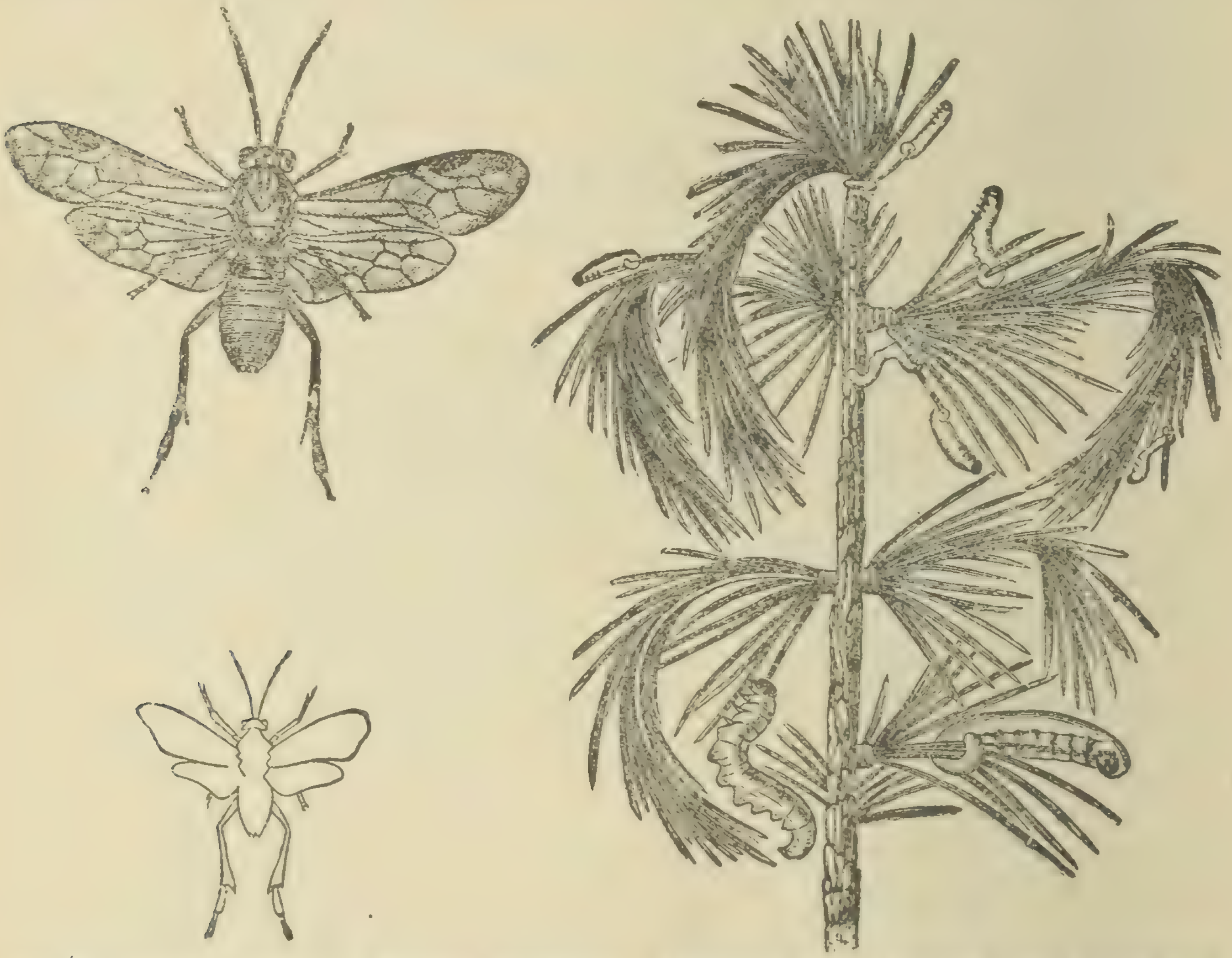

Fig. 22.—The larch saw-fly, NEMATUS ERICHSONII, in natural size and enlarged, and the larvæ in different stages in natural size. (After Packard.)

At this time the larvæ had entirely left some of the trees, while on a few they were still feeding in small numbers.

The following inquiry of this insect from a gentleman of Kings county, Prince Edward Island, Dominion of Canada, and giving an account of its ravages in the Province, and my reply to the same, is from the *Country Gentleman*, of November 13, 1890 (page 905).

Eds. C. G.— The juniper or larch (*Larix Americana*), which abounds in this vicinity, and, in fact all over the Province, is being devastated of its leaves, and presents a withered, decayed appearance through the action of the saw-fly, *Nematus Erichsonii.* The first indication of this pest was noticed in the summer of 1889, but this summer the injury has been so much aggravated that in the months of July and September it was rare to see a green leaf on a tree. Now, however, they are free from the attacks of the pest, as the larvæ, when matured, fall to the ground, leaving the tree to make a little growth by the aid of the autumn rains. Whether this pest is going to exterminate the larch completely in this Province remains to be seen. It has, however, done great injury to the larch in Nova Scotia. I am informed that the fly was first noticed near Boston, Mass., in 1880. I am also told that there is no remedy to allay the ravages of the fly. Does the sage associate of this paper know of any means? I would like to hear from Dr. Lintner on the subject.— J. A. M., Kings Co., P. E. I.

The communication above gives an interesting account, from an entomological standpoint, of the first notice and rapid spread and serious ravages of this introduced European insect in Prince Edward Island. Its operations there appear to be similar to those which seem everywhere to follow its spread.

That there is no remedy, so far as known, to allay the ravages of the insect is unquestionably too true. When the larvæ make their attack upon an isolated tree in cultivated ground, they may be destroyed by an arsenical spraying, but, as I have elsewhere written, when large areas of the larch are infested, as tamarack swamps, it is useless to attempt to compete with the enemy. Its destruction through any applications that could be made would be altogether too costly to warrant the outlay required. The best that could be done in such cases would be to fell the trees as soon as it is noticed that they are dead or doomed, and before decay has impaired their value, and use them for some of the many purposes for which the timber is available. A somewhat extended and illustrated account of this larch saw-fly appears in my *Fifth Report on the Insects of New York.*

Feniseca Tarquinius (Fabr.).

The Little Orange Butterfly.

This, usually rare butterfly, was frequently seen in Keene Valley during the months of July and August, of 1891. Attention was ordinarily drawn to it by its short, rapid flights in the roadways, flitting at a height of about ten feet from the ground, often in pairs chasing one another, or, if driven up from the leaves, flying about for a brief time and then returning and alighting upon the branch it had before occupied. It was seldom active except in bright sunlight and at about the middle of the day. In a single instance only was it seen to alight on the ground — in the Wilmington Notch, Adirondack Mts., August 6th, 1891. Examples of the butterfly were taken by me in Keene Valley on the following dates: July 20, 24, 27, 29, August 4, 5, 15, 20. Most of those collected in August were more or less worn.

A larva was found in a colony of *Pemphigus tessellata* (Fitch), on July 20th, which was nearly mature, for after having eaten a few hundred aphides it transformed to a pupa on the side of the box containing it. Brushing from the alder a colony of the aphides for food for the caterpillar, three additional caterpillars were discovered in the box the following day which were unobserved at the time of collecting. It was subsequently noticed that a lump-like accumulation of the aphides on the alder twig usually indicated the presence of a nearly full-grown larva beneath it.

It was observed that *Pemphigus tessellata* was much less abundant in Keene than in former years. Probably its numbers had been largely reduced by the Feniseca caterpillars of the first brood.

Of the four larvæ mentioned above, the first pupated on July 23d. Of the other three, the time of pupation was not noted, but was between August 4th and August 8th; of these the first butterfly emerged on September 11th, and a second one during the latter part of November.

Eudryas grata (Fabr.).

The Beautiful Wood-nymph.

With the increase of this insect and the fondness of the caterpillar for the leaves of the Virginia creeper, *Ampelopsis quinquefolia*, it may develop into a household pest. In the spring of 1890, several of the pupæ were found beneath the border of a carpet in the rectory of Grace Episcopal church, in Albany, into the substance of which they had partly burrowed for pupation, and had inflicted some injury by cutting the threads. Almost the entire side of the rectory is covered, and the windows quite surrounded, with the Ampelopsis, but the caterpillars had not been observed as unusually abundant during the preceding year.

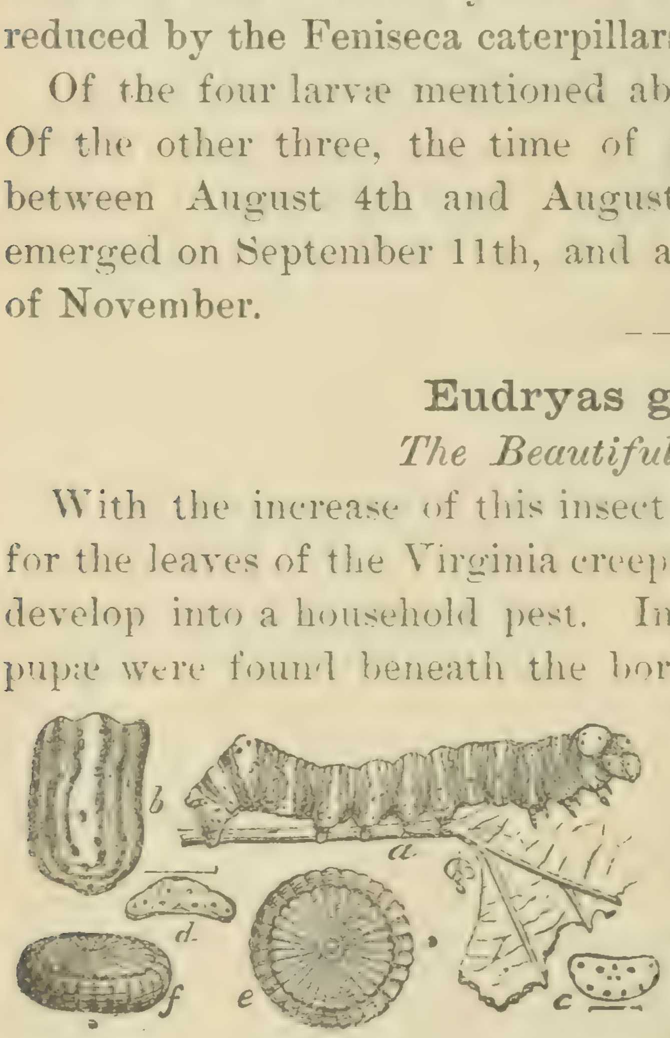

Fig. 23.– Eudryas grata; *a*, the caterpillar in natural size; *b*, its fifth segment enlarged, *c*, its collar; *d*, markings of the hump on the eleventh segment; *e*, an upper view of the egg, and *f*, a side view: each enlarged from the natural size shown beside them (after Riley).

The caterpillar, which is beautifully marked in black and orange bands (six black ones and one orange on each of the principal segments) and black spots, is shown at *a*, in Figure 23; at *e* and *f*, the delicately ribbed egg of the moth is represented in enlargement, showing its flattened form. In Figure 24, the moth is shown. When seen, in nature, in its varied and tender colors, the names that it bears—both the popular and the scientific, can not fail of being appreciated. See Fifth Report of this series, 1889, p. 181 for its description.

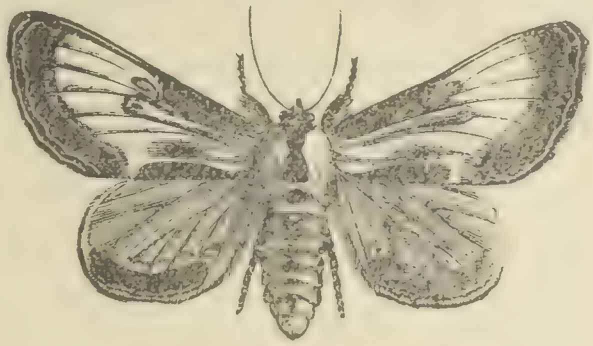

Fig. 24.—The beautiful wood-nymph Eudryus grata (after Riley).

Scoliopteryx libatrix (Linn.).

The Scallop-Wing.

The caterpillar was taken in Keene Valley, N. Y., in July, feeding on the leaves of willow. At maturity it presented the following features:

Length, 1.75 inch, cylindrical, slender (about one-eighth of an inch broad), tapering at the extremities; velvety green. Head green, as broad as the first segment, traversed mesially by a delicate red line. Abdomen with a yellow or cream-colored line midway between the dorsum and the spiracles, edged below, interruptedly, on segments two to six, with black. Spiracles bordered with orange. Setæ from the setiferous spots, short and inconspicuous. (See figure given by Dr. Packard in the Fifth Report of U. S. Entomological Commission.)

The caterpillar spun its thin cocoon between leaves attached to some threads by its anal spine on the morning of July 24th; on the 26th, it had transformed to the pupa. The moth emerged August 5th — eleven days pupation.

I had previously given the characters of this caterpillar in my *Entomological Contributions* No. I, 1872, p. 63. The following differences therein from the above may be noted: The yellow lateral stripe is shaded beneath with brown; head crossed by a black stripe; pupation of the summer brood from fifteen to twenty days. (See, also, note in *Ent. Contrib.*, III, 1874, p. 164.)

I have taken this moth on May 6th, which was probably a hibernated individual. Stainton remarks of its habits in England*: "The single species of this genus is well known for its hibernating faculties and

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**Manual of British Butterflies and Moths*, 1857, i, p. 308.

partiality to out-houses; it is consequently frequently met with by incipients during the winter months, and may be found on the wing at the end of April and in May."

The moth was of common occurrence "at sugar" in collections made by me at Schenectady, N. Y., in the year 1875, having been taken July 8 (sugaring commenced July 7), 10, 12, 13, 14, 15, 20, 24, 30. The following year it was taken or noted, also "at sugar," on May 20 (not on sixteen succeeding nights of sugaring), June 26, 27, 28, 29, July 1, 3, 7, 8 (being each night of sugaring), 15 (absent on ten nights following), August 9, 10, 14, 19 (not seen on September 4 and 6, when the collections were discontinued). It was the most numerous during the last of June. These observations indicate two broods a year — in June and August. According to Guenée, Noct. ii, page 405, it has, so to speak, no fixed time for its appearance from the pupa. Roüast, in his *Catalogue des Chenilles Européennes*, gives as the food-plants of the caterpillar, willow and poplar, in summer and autumn. With us it has only been recorded on the willow.

Exechia species ?

A Fungus Gnat.

A number of specimens of this fly were brought to me by Mr. A. L. Train, as having occurred in such abundance in his room, in Albany, as to excite his curiosity as to their source and purpose.

Being unknown to me, they were submitted to Mr. F. Kowarz, the distinguished Dipterologist of Franzensbad, Bohemia, for name and habits, if known, who very obligingly returned the following information in regard to the insect:

> It belongs to the genus *Exechia* Winnertz, of the family of *Mycetophilidæ*. Baron Osten Sacken does not mention this genus in his *Catalogue of North American Diptera*, 1878. The various species of *Exechia* live, like their kindred, almost all in mushrooms, which are fully destroyed by the larvæ of *Mycetophilidæ*. To speak of their utility or destructiveness in an agricultural sense depends altogether on the value of the mushrooms for the farmer. With us the opinion regarding mushrooms is divided.

Mr. F. V. Theobald, in his volume just published — *An Account of British Flies* — states that the *Exechia* larvæ live in fungi. *E. fungorum* and *E. lateralis* are common British species, while eight other species occur in England. These fungus gnats often appear in great numbers on windows in houses, especially in the autumn.

Telephorus ?bilineatus (Say);

Occurring on Snow.

A remarkable occurrence of the larva of what is believed to be the above named insect, was reported by Mr. Holdredge, of Center, Herkimer county, N. Y., through Mr. Daniel Batchelor, of Utica, N. Y.

Mr. Holdredge's statement is, that on or near the 10th of February last (1891), during a rain, the insects "fell" by millions on his farm and upon the adjoining one, owned by Mr. Morgan. For the distance of a half mile and for about twelve rods in width, the snow was literally alive and black with "the worms," while beyond this strip in every direction, they were quite, but less, abundant. They were seen to travel about for a day or two, while some of them penetrated into the snow, and others were frozen stiff on the surface. Some of the frozen ones were taken into his house, where exposed to warmth, they became active and quite lively again.

Examples of the larvæ sent me were submitted to Dr. Riley, and were identified by him as those of *Telephorus bilineatus*, with the possibility of their being *T. Carolinus* (Fabr.), the northern representative of the genus. While according very well with the former, there appeared some slight differences in the density of the velvety covering. Figure 25 (after Riley), illustrates the insect, and Figure 26 (after Packard), the larval head and prothorax from above and below.

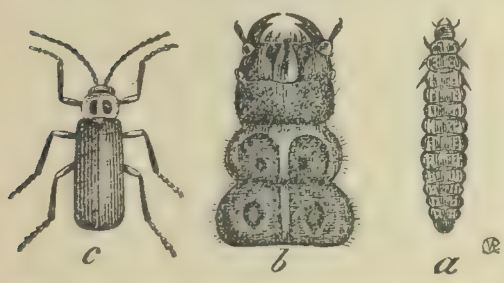

Fig. 25.—Telephorus bilineatus: *a*, larva, natural size; *b*, head and anterior segments enlarged; *c*, the beetle, natural size.

The explanation of the larvæ appearing on the snow would be, that they were drawn from the ground by the [warm?] rain, and with the change of rain into snow, they continued, with its increasing depth to mount to the surface, as other larvæ have been known to do. (See the account of the occurrence of the bronze-colored cut-worm, *Nephelodes violans* Guen., on snow, in Canada, and in Sullivan county, N. Y., related in the *Fourth Report on the Insects of New York*, 1888, pp. 54–56.)

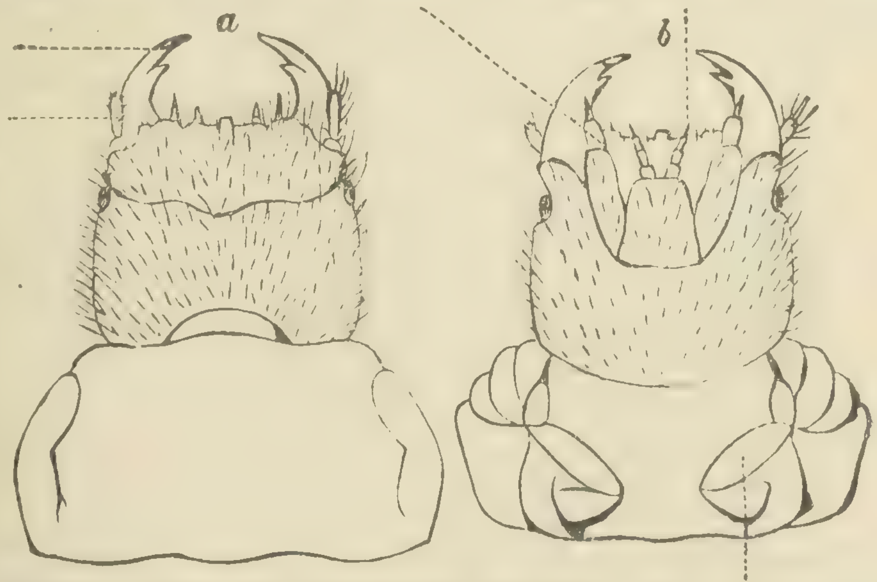

Fig 26.—Head and prothoracic segment, from above and below of Telephorus bilineatus.

Another singular occurrence of this Telephorus larva is that in which many specimens were drawn up from a well in Bloomfield, Conn., adhering to the bucket, from the latter part of November, 1875, to the month of April following, being the most abundant about Christmas, on which day forty or fifty were drawn up at once. Dr. Riley's explanation of their presence, is that "they must have been feeding upon small animals in the crevices between the bricks [stones?], from which they occasionally fell into the water and instinctively adhered to the bucket."*

Of the normal habits of *Telephorus bilineatus*, Dr. Packard states, that Mr. P. S. Sprague has found the larva near Boston under stones in the spring, when it pupates, and early in May becomes a beetle.

It should probably be regarded as a beneficial species from its habit of feeding on other insects. Dr. Riley has bred the beetle from larvæ found feeding on the apple-worm of the codling-moth, *Carpocapsa pomonella*, and has frequently met with it under apple trees among early wind-falls, where it was probably searching for the worms of the infested fruit. He has also found it in the tree upon the apples. The perfect insect appears to be mainly a vegetable feeder, having been shaken from the branches of plum, peach, and apricot trees. Dr. Packard states that early in May it feeds on the newly expanded leaves of the birch.†

This insect belongs to a subfamily of the *Lampyridæ*, or fire-flies, viz., the *Telephorinæ*. No light-organs exist in any of the species. "They are more active than the other *Lampyridæ*, and are often found upon flowers, or running over the surface of leaves in search for their prey, which seems to consist mostly of the soft larvæ of other insects" (LeBaron).

?**Lachnosterna fusca** (Fröhl.).

White Grub of the May Beetle.

In reply to a request from Red Bank, N. J., for name and habits of specimens sent, the following answer was made through the *Country Gentleman* of October 29, 1891:

The insects sent are white grubs, varying in size from about one-fourth grown to nearly full growth, and are from egg deposits of different years. They are either the "white-grub" of the common May or June beetle, *Lachnosterna fusca*, or a nearly allied species. There are a number of these *Scarabæidæ* which so closely resemble *L. fusca* that the beetles can be with difficulty separated, and indeed we do not know, or do writers agree, which should be recognized as species or regarded merely as varieties. Dr. Horn, in his "Revision of the Species of Lachnosterna of North America,"* has referred twenty-one species to the *L. fusca* group, while more recently Professor J. B. Smith has found structural features in six forms previously confounded with *L. fusca*, and has named them as species.†

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* *First Annual Report of the U. S. Entomological Commission*, 1878, p. 303.

† *First Annual Report of the Injurious and Beneficial Insects of Massachusetts*, 1871, p. 26.

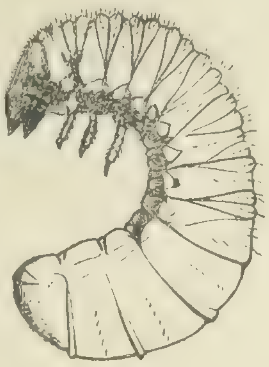

FIG 27 — The White-grub of LACHNOSTERNA FUSCA (*Fröhl.*).

The little that is known of the larvæ of these beetles renders it absolutely impossible to separate and determine them. After enumerating and characterizing ninety-one species of American Lachnosterna, Professor Smith makes regretfully this confession: "As it stands at present, *we do not know, positively, the larva of a single specie of Lachnosterna.*"‡

The habits of these "white-grubs" of the *fusca* and nearly allied groups, may be presumed to be very much alike — all feeding on the roots or grasses, various plants and shrubs, or other vegetation.

Although the examples sent can not be positively named, yet if there is anything connected with their finding that renders it particularly desirable to know more of them, they will be given further study for approximate determination.

Cyllene pictus (Drury).

The Hickory Borer.

Some insects taken from burrows in dry hickory wood were received early in March, from New Market, New Jersey, with inquiries of them.

They were recognized as the pupæ of the hickory borer, *Cyllene pictus*, formerly known and appearing in many of our entomological writings, as *Clytus pictus*. This species was confounded with the locust borer, *Cyllene robiniæ* (Foerst.), for a long time, and until it was separated from it by distinctive characters by Mr. Walsh, in 1864.§ The females of the two species can be distinguished only with difficulty, but the male of *C. pictus* can be readily known by its antennæ longer than the body, and quite

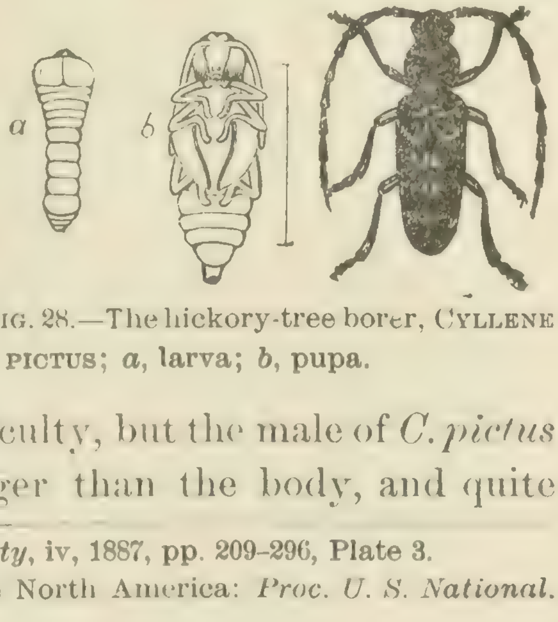

FIG. 28.—The hickory-tree borer, CYLLENE PICTUS; *a*, larva; *b*, pupa.

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* *Transactions of the American Entomological Society*, iv, 1887, pp. 209–296, Plate 3.

† Notes on the Species of Lachnosterna of Temperate North America: *Proc. U. S. National. Museum*, xi, 1889, p. 503.

‡ *Id., ib.*, p. 523.

§ *Proceedings of the American Entomological Society*, iii, 1864, pp. 420–422.

stout; and "the wing-covers widened at the base and tapered toward their tip, so that the two together just before their extreme tip equal the basal width of one of them." The insect is represented in its several stages in Figure 28. In the pupæ received, the characteristic w-marking in yellow of the black wing-covers, and the yellow transverse bands of the thorax are already to be seen, indicating that they are near their perfect stage. The beetles may emerge, if kept in a warm room during the month of March, although under their natural conditions they would not appear until May or June. The species never injures hickory trees to the extent that its congener does locusts. In many localities the locust trees have been entirely destroyed by this pernicious borer.

A detailed account of the larva (grub) of this species is contained in the *Fifth Report of the U. S. Entomological Commission*, by Dr. Packard, 1890, page 287.

In addition to the hickory (*Carya alba*), *C. pictus* also burrows in the black walnut (*Juglans nigra*) and in the butternut (*Juglans cinerea*).

This species appears abroad early in the spring (in May and June), while *C. robiniæ* occurs during the month of September. Remembering this will enable any one to identify at once the examples of the two from any that may be captured abroad, or from dates of collections indicated in cabinets.

Tenebrio molitor (Linn.).

The Meal-worm.

Two of the pupæ and two beetles, identified as the above named insect, were received from Newark Valley, N. Y., as having been found, together with many of the "grubs," in Ashton's factory-filled salt which had been stored, unopened, for two months in a tight meal room. The question was asked how they came there and if it was safe to use the salt in which they occurred, in butter and food.

If the pupæ and beetles sent were actually found *within the salt*, the following explanation of their occurrence there, is the only one that presents itself. The meal-room, in all probability, harbored numbers of the meal-worm — the larvæ of the beetles. After having fed to maturity on the meal or flour at hand, in leaving it for some convenient place for transformation to the pupal and perfect stages, they entered the sack or barrel through some hole or crevice

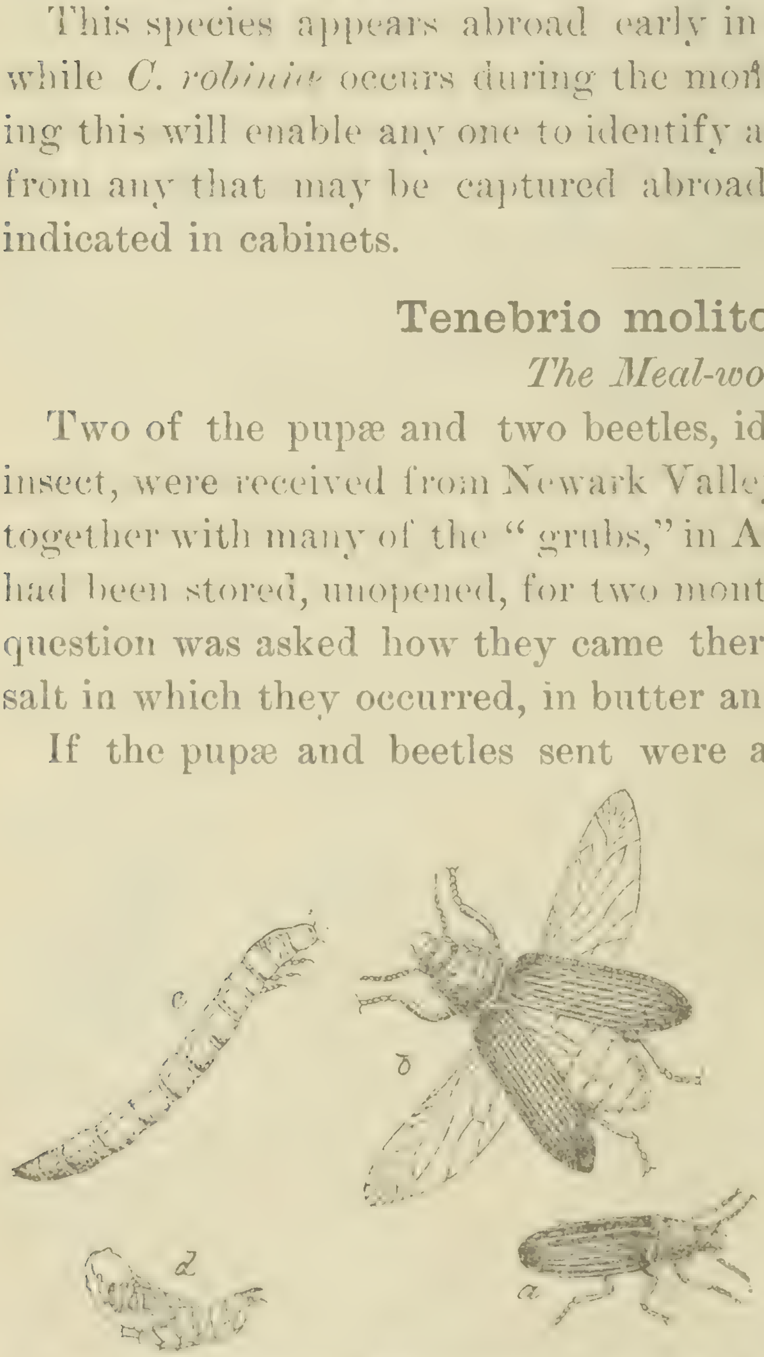

Fig. 29. The meal-worm, TENEBRIO MOLITOR: *c*, *d*, *a*, the larva, pupa, and imago, natural size; also the beetle enlarged.

where, after their changes, they were found. The larvæ could not feed upon the salt, nor could it be of any particular service to them in any manner. Their presence would not in the slightest degree impair the value of the salt for use. The pupæ would be readily seen; the beetles would at once escape, and no eggs would have been deposited in the salt.

The insect has not been figured by any of our writers. The accompanying illustrations of its larval, pupal, and perfect stages are from Curtis' *Farm Insects.* In shape and general appearance the beetle is much like *T. obscurus* Fabr., but while that is of a dead opaque-black color, this is of a shining black. Its larva "is about an inch long, cylindrical, smooth and glossy, with the terminal segment semicircular, slighly serrated on the edges, and terminated in a single point" (Packard). Curtis describes it as "cylindric, smooth, ochreous, with bright rusty bands and a few scattered hairs; two small horns, six pectoral legs, and two minute spines at the tail."

It is a common species in the Old World, and has been quite largely distributed by commerce in all commercial countries. It is said to have been recently introduced, intentionally, in Chili for the purpose of using its larvæ for bird-food.* Dr. Packard's remark, "that it is found in all its stages about corn- and rye-meal, and is frequently swallowed with food," finds apparent confirmation in a notice entitled, "Larvæ of Tenebrio molitor in a Woman's Stomach,"† in which two insects reported by a physician to have been ejected from the stomach, are identified as the above, and the statement accepted as probable, with the suggestion that the larvæ may have been swallowed without undergoing mastication in corn-meal mush; the irritation that their movements would occasion, would naturally excite vomiting and their ejection.

Another account of this same insect, which is quite amusing, is related, where the scratching sounds caused by a number of the beetles which had bred within a pin-cushion filled "with coarse shorts," led the guest at a hotel to believe, and make complaint, that the room to which he had been assigned, and in which he had passed a sleepless night, was haunted.‡

Pulvinaria innumerabilis (Rathvon).

The Maple-tree Scale Insect.

Referring to the notice of this insect in the *Sixth Report on the Insects of New York*, Mr. Andrew S. Fuller, in a communication to me, under date of February 20th, 1891, has written as follows of its increase and injuries as observed by him, in the city of Brooklyn, N. Y.:

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* *Insect Life*, i, 1888, page 154.

† *Id*., page 379.

‡ *Id*. ii., 1890, page 148.

The *Pulvinaria innumerabilis* is not only destroying all of the soft maples, *Acer rubrum*, and white or silver-leaved maple, *Acer dasycarpum*, in the city of Brooklyn, but it has also invaded the gardens and is rapidly destroying the grapevines, and the Japan ivy, *Ampelopsis Vetchii*, which covers the brick walls of many fine residences and churches. On the latter the pest has a most excellent retreat and shelter, and can not be dislodged by ordinary remedies. There are already many thousands of trees dying from the attack of this sucking pest, and the city is doing nothing to check it. A few thousands of dollars properly expended a few years ago might have saved the trees, but now a million of dollars would not replace the damaged trees. I have written several articles calling the attention of the residents of Brooklyn to this pest, and made one report to the Board of Parks (by request) on the same, but the owners of fine shade trees groan over their loss but make no practical effort to repair it.

The future entomologist is likely to have quite as much to do as those of the present day, and it is to be hoped that his labors will be more highly appreciated.

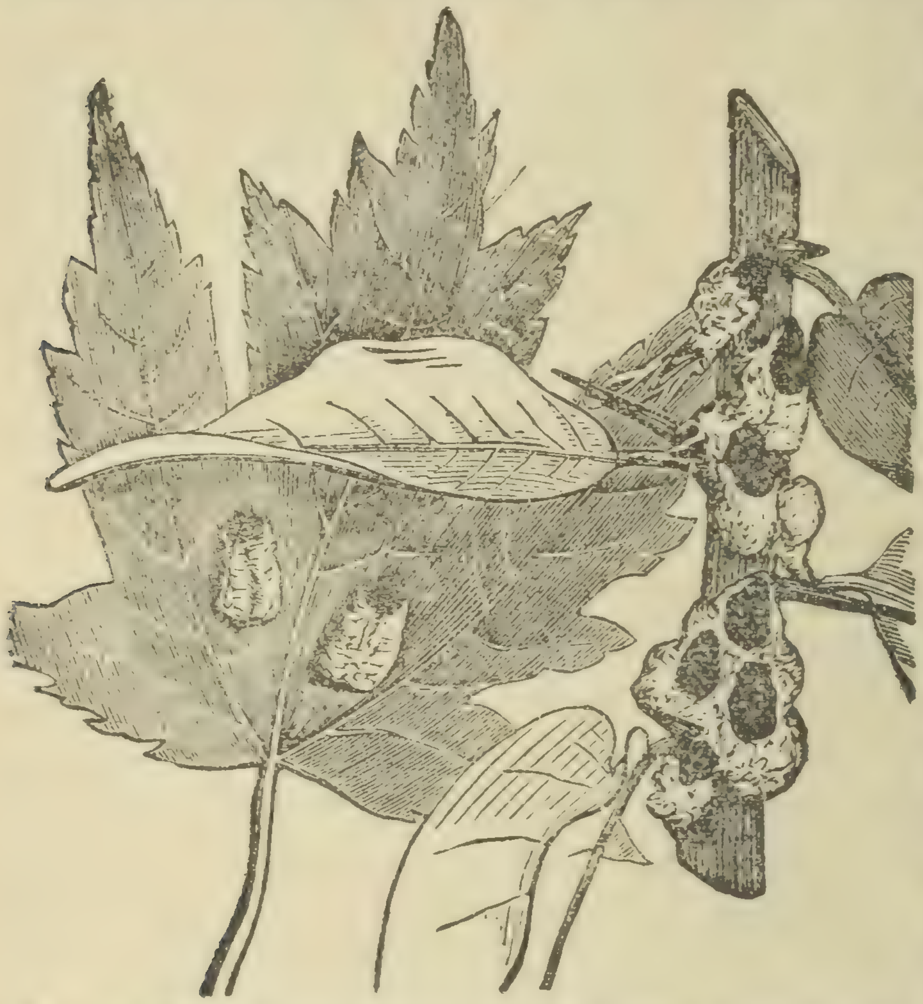

FIG. 30.—The maple-tree scale insect, PULVINARIA INNUMERABILIS.

The scale of the insect with the large, white, cottony mass thrown out from beneath it for the protection of the eggs and the newly-hatched young is represented in Figure 30.

Mr. E. P. Van Duzee, of Buffalo, N. Y., in a letter dated February 28th, 1891, has written of the large numbers of this insect observed by him, after the falling of the leaves the preceding autumn, on the maples planted as shade trees along the streets of Buffalo. He was apprehensive that, in their increase, they would prove to be a great scourge the following summer.

Gryllus luctuosus Serville.

The Common Black Cricket.

Mr. Wm. B. Marshall, of the New York State Museum, at Albany, reports that during a sojourn at Cape May, N. J., in the month of July last, a suit of clothes belonging to a friend, which had just been received from the tailor, and was hanging over the back of a chair, was completely ruined in a single night by crickets that had entered through open windows and eaten large holes in the garments. On request, some of the crickets were secured and sent to me for identification. They proved to be *Gryllus luctuosus* Serv.

While we believe this is not of frequent occurrence, yet it has long been known that the *Gryllidæ* as well as the *Acrididæ* are not exclusively vegetarian in their feeding habits. Thus, Walsh has recorded of *Gryllus abbreviatus* Serv. — a species closely allied to, and usually associated with, the above, that " whenever they gained admission into houses, after eating into apples and other vegetable matter that they found there, often concluded their repast by gnawing holes into boots, shoes, and woolen clothes."* He has also remarked : "All the crickets feed indiscriminately both on animal and vegetable substances. I have repeatedly noticed *abbreviatus* under dead putrid birds, etc."†

Clothing long worn and charged with animal matter from the person and from extraneous sources, might naturally be supposed to attract crickets that have acquired the taste indicated above, just as soiled clothing has occasionally been eaten by *Dermestes lardarius*, the larder beetle; but that new woolen clothing should be eaten in preference to old, can only be accounted for upon the supposition that a special attraction, in this case, was found in the animal matter belonging to the wool, or employed in its dressing, and remaining in the woven fabric.

Trombidium locustarum Riley.

The Locust Mite.

Please give me the name and history of the parasite that deposits its small, oval, red eggs near the base of the grasshopper's wings.—I. G. I., Adena, O., September 10th, 1891.

The " small, oval, red eggs " of which inquiry is made, is the locust mite, *Trombidium locustarum* Riley. It renders most excellent ser-

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***American Entomologist*, i, 1868, p. 53.

† *Practical Entomologist*, i, 1866, p. 126.

vice — at times, of almost incalculable value — in the destruction of the eggs of the western locusts (commonly called grasshoppers), which it seeks when buried in the ground and eagerly devours. The young mites are very active little creatures, living at first in the ground where they feed on decaying animal and vegetable substances. When the opportunity is given them, they crawl upon the bodies of the locusts and attach themselves, in preference beneath the base of the wings, but sometimes, when unusually abundant, covering the entire body. While upon the locust, they are immature, being in their larval stage, and having only six legs. As they gorge themselves with the juices of their host, their bodies swell out into an oval sack-like form, almost concealing the legs, although they are long, and in this condition [represented at *a* in the figure] they may very easily be mistaken, as in the above inquiry, for eggs. After they have completed their larval growth they drop to the ground, where they undergo two changes — first to the pupa [shown at *b* in the figure] and then to the perfect eight-legged form [shown at *c* and *d*]. They pass the winter in the ground, and are said to be active whenever the temperature is a few degrees above the freezing.

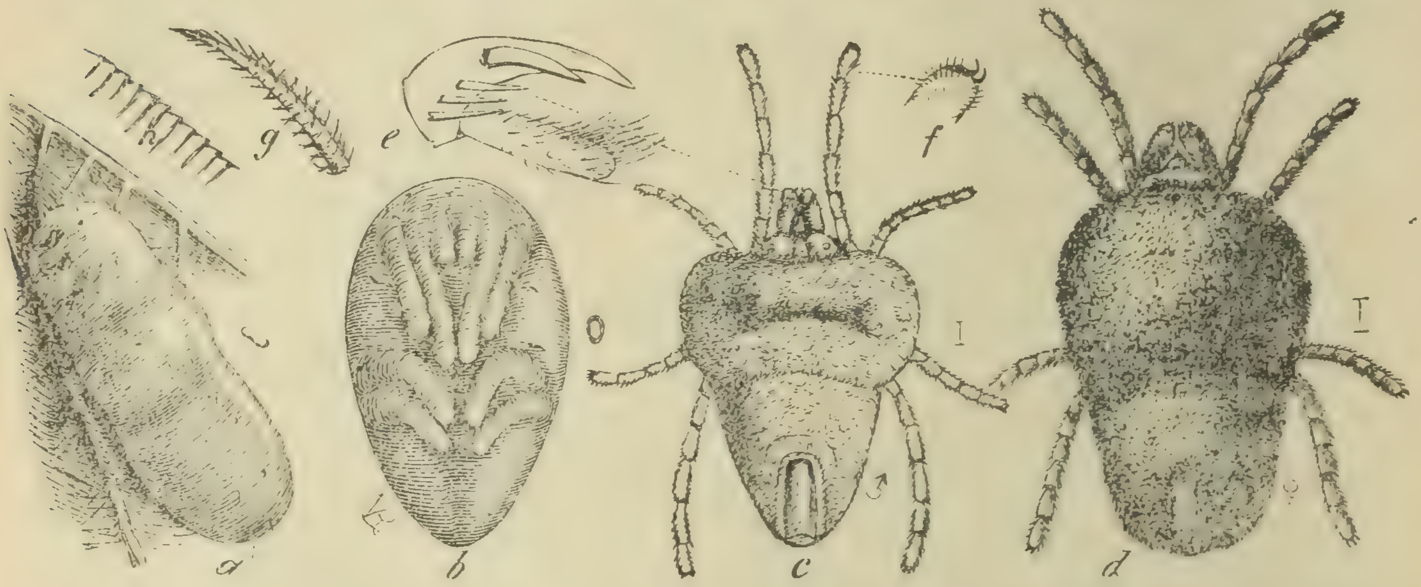

Fig. 31.— Trombidium locustarum.— *a*, mature larva when about to leave the wing of a locust; *b*, pupa; *c*, male adult; *d*, female adult; *e*, palpal claw and thumb; *f*, pedal claws; *g*, one of the barbed hairs; *h*, the striations on the larval skin. (After Riley.)

A detailed and interesting article on this mite from the pen of Professor Riley, from which the above facts and figures have been taken, is to be found in the *First Annual Report of the United States Entomological Commission*, pages 306–311.

This mite is not confined to the Central or Western States, but has been observed in New Hampshire preying in very large numbers, both on the eggs and the mature insect of the lesser locust, *Melanoplus atlanis* (Riley).*

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* Marlett, in *Insect Life*, ii, 1889, pp. 67, 68.

INSECT ATTACKS — THEIR REMEDIES AND PREVENTIVES.

The number of our more injurious insect pests is so large that comparatively few have been treated of in the seven preceding reports of the State Entomologist. It is desirable that each should be presented to the agriculturists of the State of New York in such detail and length of notice as would meet the requirements of the more advanced farmers, fruit-growers, and gardeners. In the main, this would be met in the presentation of the literature, history, description, illustrative figures, habits, life-history, distribution, and, above all, the best approved remedies and preventives, of the several species. A work of this magnitude, however, would require at least a score of years for its completion. In the meantime, it would certainly be of considerable service if there could be given to the public even brief notices of our more injurious pests, in which their features were sufficiently described for their identification, their transformations and more interesting habits stated, together with some simple methods by which their injuries can be prevented or lessened.

A number of notices, embracing some of the above particulars, have been contributed by the Entomologist during preceding years to agricultural papers — notably to the *Country Gentleman* and *New England Homestead*, in reply to inquiries received of the more common pests of the garden, orchard, and farm. As each of these is believed to contain matter of some importance and value, it may not be amiss to extend their usefulness by incorporating them from time to time in this series of annual reports, where they may serve some purpose (one would be, convenience of reference) until the time shall arrive when the insects of which they speak may receive more careful and studied consideration.

With the above will also be included some communications made to individuals, relating to insects of somewhat general interest.

Remedies for the Peach-Tree Borer.

The following communication was received from a correspondent in Waynesville, Ohio :

I wish you, or some of your experienced correspondents, would give directions for destroying, and also for preventing, borers in young peach trees. The principal danger seems to be while the trees are young and tender. If one has but a few trees, perhaps the best way would be to search the borer out and destroy it, but during a part of the life of this pest it is very small and difficult to find so close to the ground; besides, in large orchards it would be an exceedingly slow and expensive process.

I see in the *Scientific American*, copied from the *N. E. Homestead*, that an effectual treatment is to "make a mixture of wood ashes and water, in the proportion of one quart of ashes to a pail of water. Stir well; make a little ridge of earth around the tree, a few inches from it, and pour in the mixture. It will soak into the worm-holes, and will kill them every time." The writer says he has used it for years successfully. He says that it may be necessary to do it twice the first year, but after that a very little care will keep the trees free from them. For want of ashes a thin solution of lime will do, he says. Why not heap a quart of ashes around the tree and let the rains supply the water? Now what I want to know is, whether this treatment has been sufficiently tested to justify me or any one else in depending on it in a large way — a thousand trees or more?

Would not an application of whitewash be as good a treatment as could be desired, after the trees are two or three years old — or thick soap-suds, applied with a brush or a rag? The first year the bark would no doubt be too tender for the whitewash.

Is it not found that it greatly increases the life and vitality of the peach tree to shorten in the branches every year after the season's growth is completed? Peach trees are generally short-lived; it is desirable to prolong their lives if we can, and such treatment will probably make them less liable to break down, owing to the disposition of the limbs to grow to great length, with most of the fruit far from the trunk of the tree.

It is not a difficult task to control this insect, *Ægeria exitiosa*, the *Sannina exitiosa* of many recent writers, if the proper means are taken for it. It is possible to prevent its injuries to a great extent by the old method of searching for the presence of, and cutting out, the larvæ. There are those who contend that the destruction of the insect is the only proper thing to do, since by the applica-

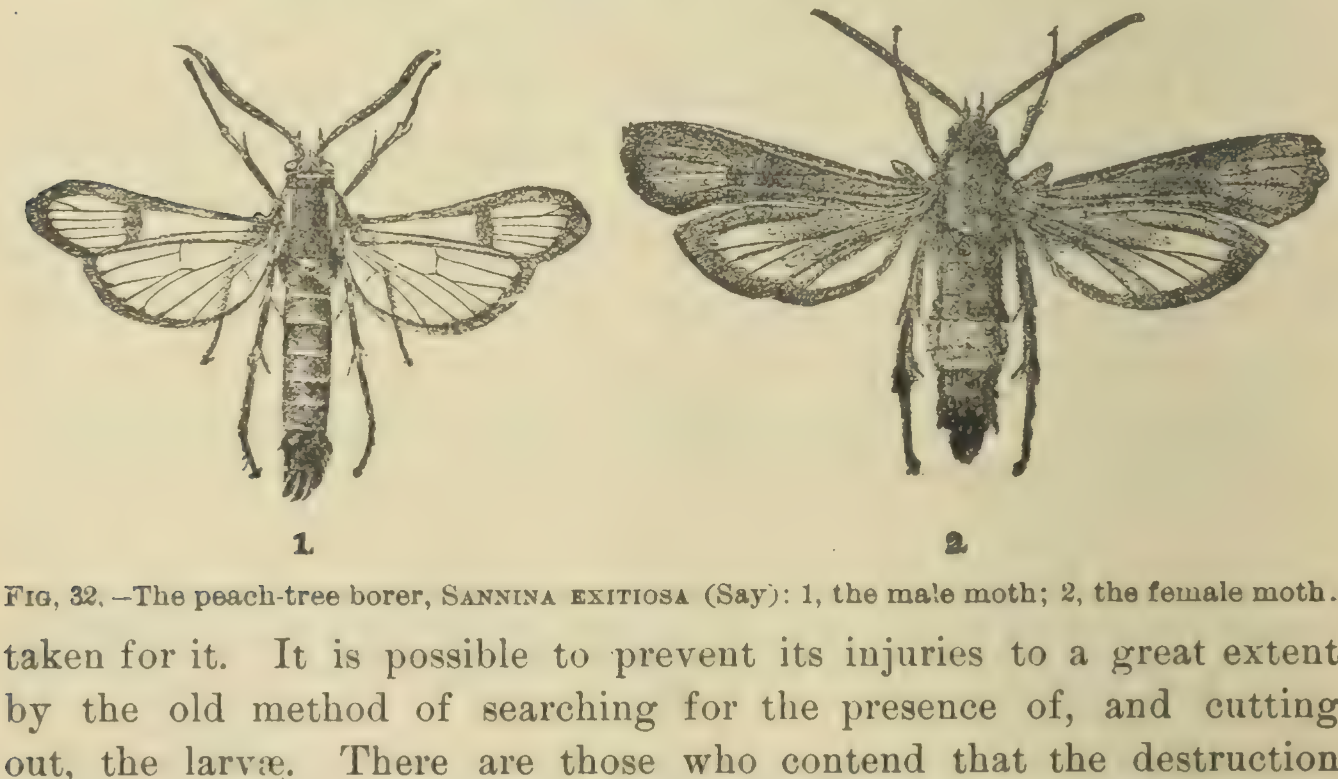

Fig. 32.—The peach-tree borer, Sannina exitiosa (Say): 1, the male moth; 2, the female moth.

tion of preventives you do not reduce its number, but only drive it away to unprotected orchards. A sufficient answer to this is, that there should be no unprotected orchards, and that the peach-grower who is too ignorant or indolent to employ the simple and inexpensive means by which his trees may be protected, does not deserve that they should give him remunerative crops.

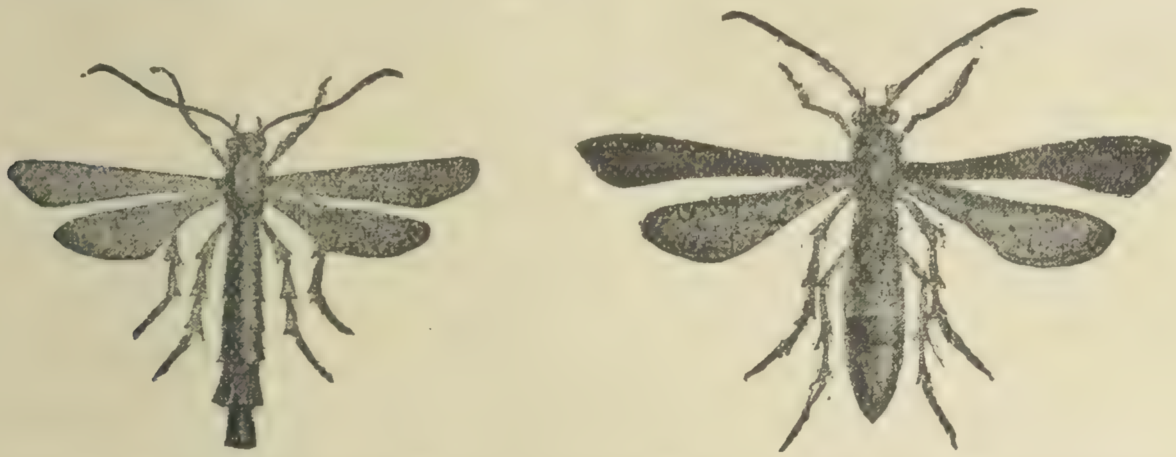

Fig. 33.—Male and female moths of the peach-tree borer, enlarged (after Emmons).

[The male and female moths, which are quite unlike in appearance, are shown in Figure 23, in twice their natural size, taken from Dr. Coquillet's "Our Injurious Ægerians," in vol. v of the *Journal of the Columbus Horticultural Society.* Figure 33, after Emmons, also illustrates the same insects.]

The treatment quoted above, of wood ashes and water placed in a funnel-shaped cavity about the tree, would unquestionably serve a good purpose in the destruction of the eggs and the young larvæ, if applied a few days after the deposit of the eggs or their hatching. But as the period of egg-laying of the peach-tree moth extends over the months of June, July, and August, it would require too frequent an application of the ash remedy to render it reliable and practical.

Carbolic Acid Wash.

This wash has been tested for several years, and so far as we know, has never failed to give satisfaction. Several large peach-growers have used no other method of protection. Two or three formulas have been given for it, but probably the best is that presented by Mr. Bateham of Painesville, O., in the *Country Gentleman*, vol. xlv, 1880, p. 246, and also published, with others, in the *Second Report on the Insects of New York,* 1885, pp. 24-26:

"For an orchard of five hundred bearing trees we buy a pint of crude carbolic acid (or half as much of the refined), costing not over twenty-five cents; then take a gallon of good soft soap and thin it with a gallon of hot water, stirring in the acid, and letting it stand over night or longer; then add eight gallons of cold soft water and stir. We have then ten gallons of the liquid ready for use. The wash should be thoroughly applied with a swab or brush around the base of each tree, taking pains to have it enter all crevices."

Mr. Bateham gives for his locality (about 42 degrees of N. latitude), as the proper time to apply the above, during the last of June, if the weather is hot, or the first of July. He had never seen the moth depositing its eggs before the last-named date, and if eggs had been deposited a few days earlier, he claims that the wash would kill them at once.

Carbolic Acid and Paris Green Wash.

Mr. J. H. Hale, a successful peach-grower in South Glastonbury, Conn., has recommended in a paper published in the *Transactions of the Massachusetts Horticultural Society*, for 1888 (Part I, p. 66), a wash for the prevention and killing of the peach-tree borer, which would seem, on some accounts, to be even preferable to the preceding. He represents the egg-laying period of the moth to commence in the latter part of May, and continuing into September. On rare occasions he had seen the moth deposit eggs in the crotches of the larger limbs. Has this been observed, or the larvæ found in such localities by any one else?

The objects sought in the wash are: first, to smooth the bark; second, to prevent oviposition; and third, to kill the egg or larva if oviposition has occurred. The exact proportions are not very important. To a common bucketful of water take two quarts of strong soft soap, half a pint of crude carbolic acid, two ounces of Paris green, first reduced to a paste, with water and lime enough to form a thin paste that will adhere to the tree. A little clay may be added to assist in making it stick. Apply with a swab or brush before the first of June.

Killing the Borer.

Although the above is given as almost a sure preventive, Mr. Hale recommends that in addition, the tree should be examined in October, and where traces of the borer are discovered, as in exuding gum or the sawdust-like castings at the base of the tree, remove a little of the earth, scrape off the gum with a sharp knife, cut away the bark, and with a piece of wire follow up any channel that it does not seem best to cut open, crush or draw out the larva, which at this time will be from a half-inch to an inch long. [The full-grown larva, its cocoon, and the contained pupa are shown in Figure 34.]

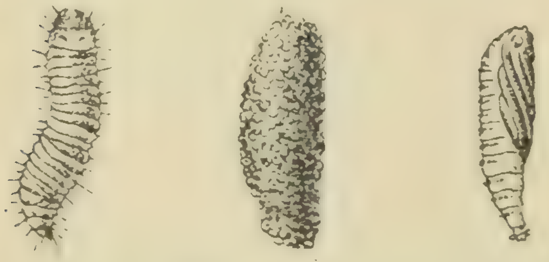

Fig. 34.—Larva, cocoon, and pupa of Sannina exitiosa (after Emmons).

The Shaker Peach-tree Borer Wash.

The following is the recipe of the wash in use by the thrifty Shakers of Shaker Station, Hartford Co., Conn., which has been sold for past years at three dollars, but has recently been communicated to the *New England Homestead:*

Fish oil, 3 pts.; soft soap made from wood ashes, 3 pts.; whale-oil soap, 2 lbs.; powdered sulphur, 2 lbs. Mix the oil with the whale-oil soap, beating the lumps up thoroughly into a perfect emulsion. Then add the soft soap and, after mixing this thoroughly, stir in the sulphur. The more perfect the mixing is done the better. These ingredients can be obtained at almost any country store, and ought not to make the cost more than sixty cents the gallon. One man can mix a barrel and apply it to five hundred trees in a day. The application should be made every spring from May 15th to June 1st, in latitude 42°.

Preparatory to applying the above, it is recommended to remove with care, by the aid of a wooden trowel and broom, the ground for about a foot from the trunk, so as to lay bare the base and main roots. Examining them after three days, if any borers are present, they will be discovered at a glance by the oozing gum and their excrements or borings, and can be easily cut out with a sharp knife. After which, apply the compound with a paint brush to the cleaned roots, and up the trunk for eight or ten inches above the surface of the ground. Sprinkle on all the powdered sulphur that will adhere, and return the ground.

Mounding.

This method of protection is highly esteemed by some peach-growers. It is done by throwing up around the base of the tree, at any time before the deposit of the eggs, a mound of earth of about a foot in height, and pressing it closely to the trunk with the foot. In the following years, a few inches may be added annually. By this means the roots of the trees where they are given off from the trunk, are placed out of reach of the insect. The mounding is believed, also, to have a beneficial influence on the health of the trees, in prolonging their period of bearing and exempting them from disease. It has been claimed that this method has given entire exemption from the borer attack, at the cost of a very little labor.

A New Tree-Protector.

A model of a device has lately been shown me which promises to give complete protection for young trees from the attack of the peach-tree borer. A cylinder made of fine wire netting, about fifteen inches high, mounted on a galvanized metal base, gathered in at the top so as to adjust itself closely to the tree, opens at one side for passing it around the trunk, and is then secured and fastened to the ground, and slightly into it, by a sliding pin. With this protection, the moth would be effectually prevented from depositing an egg upon or near the base of the tree. The cylinders could be quickly applied, and with proper care in housing them, they would last for many years. It is thought that they can be offered for sale at about twelve dollars the hundred.

It is undoubtedly very beneficial to shorten-in peach trees annually. It can be done in the autumn, or in the early spring, by clipping off at least one-third of the last year's growth.—*Country Gentleman*, for June 4, 1891.

In a communication to the *Rural New Yorker*, of October 17th, 1891 (page 736), Mr. J. S. Woodward, the ex-secretary of the New York State Agricultural Society, and a highly successful fruit-grower, condemns the recommendation made in a late number of the same journal (page 593) for treating trees infested with the peach-tree borer, by piling wood ashes just about the body of the tree and on the roots after some of the surface soil has been removed. He had seen trees killed from leached ashes piled about them, and unleached ashes would be almost sure death, and besides, they would be effective, if harmless, only for a short time. Mr. Woodward gives the following preventive for the borer as being entirely safe, and as sure as it is safe:

Take some dirty soap — the dirtier the better,— and add to it sweet skim milk so as to make strong soap suds. Into this mix hydraulic cement (common water-lime) in quantity sufficient to make a thick white-wash, and using a stiff brush or old broom, with this coat the trees from the ground or a little below, to from twelve to eighteen inches above, using plenty of the wash. This will form a solid coat of mail that no insect can penetrate, and unless broken with hoe, harrow or other tool, will last for a full year, or until the growth and expansion of the bark of the tree fills it with cracks. To eradicate borers already lodged in the tree, there is nothing so good as a sharp, strong knife and a sharp pointed wire.

AN ICHNEUMONIZED CATERPILLAR — INTERESTING CASE OF PARASITISM.

EDS. COUNTRY GENTLEMAN.— Inclosed I send a peculiar worm found on my hop vine. At time of finding it was of a light green color, two and a half inches in length. Please name, and state whether it is in any way injurious to the plant. Last year I found on the same vine two worms, dark brown in color, with highly iridescent spots all over them, shining with metallic luster, while the worms themselves were almost as heavy as so much lead. I put them in a box, but neglected to send them until they became too shrunken for examination.

MRS. K. M. B., *Wabash, Ind.*

The caterpillar taken on the hop vine comes in such a shriveled and broken condition that it can not be definitely named, but it is one of the Sphinges, and an examination of its head indicates that it is probably that of *Darapsa Myron*. This species feeds on the grapevine and the Virginia creeper, but many larvæ leave their food-plants and wander to other vegetation after they have reached maturity. I do not know of any species of the *Sphingidæ* that feeds upon the hop vine.

The caterpillar had been attacked by an ichneumon fly, which had inserted within its body over one hundred eggs. These had hatched and fed to maturity inside of the caterpillar, when they ate their way out of the body, each through a separate hole, and spun upon its surface small, elongate, oval, white cocoons, standing on end, and, from their number, nearly covering the entire body, as shown in Figure 35.

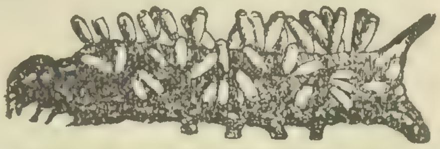
FIG. 35. — Caterpillar of DARAPSA MYRON (Cramer), ichneumonized by *Apanteles congregatus*.

An unusual circumstance attended this particular brood of parasites. While engaged in the spinning of their cocoon, they were discovered and appropriated for the prey of another parasite — a small Chalcid insect, of less than one-half the size of the larva which it attacked. A Chalcid egg was inserted in each larva — not a single one being overlooked. The cocoons were completed as usual, but their architects were thereafter made the food of their chalcid guests. As the result, instead of the cocoons subsequently opening at their upper end, by a nicely fitting hinged lid for the escape of the ichneumon fly, in each instance the perfected chalcid — a pretty metallic-green creature, with iridescent wings — has made its escape through an irregular hole eaten near the end of the cocoon.

The first parasite was in all probability *Apanteles congregatus* (Say); the second, the chalcid, has not been determined.

The "two worms with iridescent spots, shining with a metallic luster," can not be named from the characters given. Could they have been the dark brown chrysalids of the interrogation butterfly, *Grapta interrogationis* (Fabr.), ornamented with its silvery spots? This and the chrysalis of the comma butterfly, *Grapta comma* (Harris), are often known in hop yards as the "hop merchant," and are thought by some to foretell the future value of the crop, as the metallic markings may be more or less conspicuous.— *Country Gentleman*, for September 27, 1888.

A New Onion Pest, Agrotis ypsilon (Rott.).

The following editorial notice in the Canastota [N. Y.] Journal, of June 20th, 1891, refers to a new insect pest that had recently made its appearance and was the occasion of considerable alarm:

> Onion growers in the vicinity of Canastota are dismayed by the appearance of a pest that is making fearful havoc in some of the onion fields lying north and west of this village. The pest was first seen about a week ago. Growers noticed that their onions were getting thin and the plants appeared to be dying. Investigation, however, disclosed the fact that the plants were being eaten by a voracious dark-colored worm. The worms were of all sizes up to about one inch and a quarter in length and the thickness of a lead pencil. They seemed to work in spots, some parts of a field being overrun with the worms while in other places no traces of the pest could be found until they had migrated from the infested portions. Where they appeared, they were very numerous and quickly ate all the vegetation, including weeds.
>
> The muck land lying north of Canastota, and in the adjoining portion of the town of Sullivan, is peculiarly favorable to the profitable culture of onions, and great quantities of them have been raised during the past five or six years. Hundreds of acres were sown to the fragrant vegetable this spring. The work of the worms will be of incalculable damage to the crop. The loss at present is estimated at one-fourth of the total acreage.

Examples of the caterpillar, as they proved to be, were received from the editor, Mr. P. F. Milmoe, with request for their examination and for aid in the emergency. Reply was returned, under date of June 17th, as below:

Editor of Journal.— Dear Sir: Yours of yesterday, informing me of the severe attack in the onion fields of your vicinity, and accompanied by specimens of the depredator, is just received, and I send immediate reply.

These sudden outbursts of insect injury are not infrequent occurrences, and are often impossible to account for satisfactorily. On reading your note, I confidently expected to find, in this instance, a repetition of the attack made in the spring of 1885 upon the onion fields in Goshen and vicinity, in Orange county, N. Y., whereby many acres of onions were destroyed and serious losses inflicted, as described in Prof. Riley's Report to the Commissioner of Agriculture for that year (pp. 270-275), through the operations of the dark-sided cut-worm, *Agrotis messoria* Harris.

The examples you have sent me show it to be a different insect — a cut-worm, but of another species. So far as I can determine from the larval characters, which are somewhat variable, and show marked differences of feature in the different stages of growth, this is the black cut-worm, *Agrotis ypsilon* (Rott.) — one of our most abundant species, common almost everywhere over the United States and Canada, and occurring throughout Europe, in the East Indies, the Hawaiian islands, and elsewhere. [The caterpillar and the moth that it produces are shown in Figure 36.] A peculiarity of this species, and one that would seem to add to the amount of injury that it may cause the onion grower, is the unusually long time that it is present with us. It is almost the earliest of the *Agrotis* species to make its appearance in the winged state. I have taken it as early as May 30th, and in collections made by me "at sugar," have observed it every night through the months of June, July, and August, over half the nights of September, and continuing until the last week of October. This would seem to indicate that its caterpillars are in the ground and continue their depredations through most of the spring and summer months. Whether this is the result of a long period of egg-laying of the moth, giving us the caterpillars at various stages of growth throughout the season, or if there are two or more overlapping broods, we are unable to say. Of some of the cut-worms, we could safely predict that they would disappear from view and their injuries cease within a limited time — a week or two,— but of the black cut-worm, no such gratifying prediction can be made. It may speedily disappear or its trouble may continue for several weeks longer. The size of the worms at present will enable you to form some opinion of their future operations. Those sent me are nearly full-grown. If nearly all are of this size — an inch and one-fourth in length when at rest — I would expect that their work would cease within two weeks from this time, when they should stop feeding, bury in the ground and form a cell for their pupation, from which they would emerge later as the winged moth. But if many of the larvæ are still small, you would be compelled to look forward to a longer battle with them. What shall be done with them to stop their ravages? This is the important question with the onion growers.

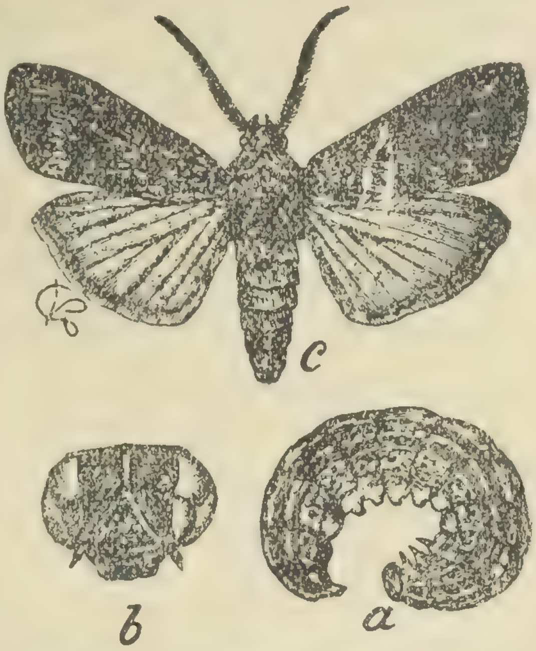

Fig. 36.—The black cut-worm, Agrotis ypsilon: *a*, larva; *b*, enlarged head of same; *c*, the moth. (After Riley.)

If I am able within a few days to go and look over the ground, I will do so, for then I could give you better advice. In the mean time I will suggest some means which, from the known habits of cut-worms, should afford very material relief. I presume that they feed mostly at night and spend the day within the ground near the plants at about an inch below the surface. If the children, with a tin pail in hand holding some water with kerosene on its top, will go through the fields, and, working away the ground with their fingers, pick out the worms and drop them into the pail, much good will be accomplished. At Goshen, it was not unusual for a child to fill a quart pail in going over a field in this manner. Night collections, with the aid of a lantern, should be made, when the caterpillars, if small, will be seen at work upon the tops of the plants, or, if larger, cutting off the plants near the base for food' or traveling over the ground. If, as possible, they are too abundant for hand-picking (although at Goshen entire nights of whole families were devoted to the work), then I would advise spraying at night with a kerosene emulsion for killing them.

The emulsion is easily made in the following manner : Dissolve in one gallon of boiling water, one-half pound of hard soap or a half-gallon of soft soap, and, by the aid of a force pump, mix with the solution one quart of kerosene until of a uniform mixture and wholly emulsified. Add to this enough water to make two gallons of liquid. This will give one part of kerosene to eight of the liquid, which should kill all the worms that it comes in contact with, without injuring the plants. If, however, found necessary, the proportion of kerosene could be increased. The above could be applied at night with a force-pump, or with any suitable sprinkler. Mr. P. C. Lewis of Catskill, N. Y., makes a pump which would be good for this purpose, at a cost of $5.50. A circular explaining it would be sent on application.

At Goshen it was found that a simple solution of a quart of soft soap in seven quarts of water, sprinkled over the plants, protected them from attack and also killed those of the worms that it reached. This is so simple that perhaps it might be first tried before resorting to the other remedies.

I trust that the above remarks will be adapted to present wants. Later, I will advise as to the best methods of preventing a recurrence of the attack another year, through preparation of the ground. I need hardly remark that the insect could not have been carried to your locality in the seed, as you suggested may have been done. You doubtless had it with you in preceding years, but not in remarkable numbers. For some reason the present year has been very favorable for its multiplication. The " black cut-worm " is known as a very general feeder, often proving destructive to strawberry plants, but I find no record of its injuries to onions. Very truly yours.

I was unable to visit the locality in season for observation of the attack, but learned that it ceased a week or two thereafter, doubtless from the maturing of the caterpillars and their entering the ground for pupation.

It is not improbable that this larva is cannibalistic at times. Mr. Milmoe had inclosed about a dozen in a close-fitting box to send to me, but being forgotten for a day, when opened, to his surprise only two remained. He had been told that the larger ones had been seen eating the smaller in the fields.

The first of the caterpillars received pupated June 16th, and disclosed the moth, *Agrotis ypsilon*, July 12th — a pupation of twenty-seven days. A second became a pupa July 2d, and a third July 6th.

The Stalk-borer, Gortyna nitela, as an External Feeder.

Mr. H. H. Rich, of Hartford, Conn., has sent, with inquiries, a caterpillar which he had detected feeding on the tassels of his corn. It is the larva of *Gortyna nitela* Guenée, probably about three-fourths grown, as it is at maturity somewhat over one inch in length. It is a well-known pest of our gardens and fields, known under the common name of "the stalk-borer," and unfortunately is one of those which makes its attack upon a large number of food-plants, quite varied in their character. In my First Report, where I have discussed the insect at considerable length (pages 110–116), its food-plants, in the stems of which it lives, are given as follows: Tomato, potato, spinach, wheat, corn, dahlias, asters, lilies, spiræa, salvia, milkweed, castor bean, rhubarb, chenipodium, peach-twigs, currant-twigs, rag-weed, and hearts-ease. It also eats the fruit of the tomato and strawberry, and bores into the cobs of ears of corn, as well as in the stalk. The above list will serve to show what a general feeder it is, and that it rarely appears except as an internal borer in stalks, stems, and twigs.

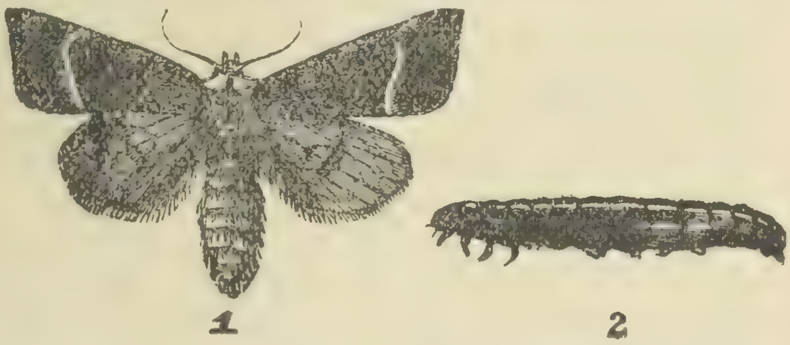

Fig 37.—The stalk-borer, Gortyna nitela *Guen.* The moth and its caterpillar. (After Riley.)

It has often been sent to me in potato stalks and in the stalks of young corn, but I have never met with it before as an external feeder. Walsh and Riley record it as boring through the cob of growing Indian corn, and strangely confining itself to that portion of the ear, and also as boring into the stem of the same plant. Miss E. A. Smith and Professor French have recorded its operations in the stalk of young corn, and other writers have mentioned like injuries from it.

The caterpillar may be easily recognized by its head, first segment, and anal plate, being of a wax-yellow color, and its purplish-brown body, conspicuously lined with three white stripes, of which the central one is continuous from the first to the last segment, while the side ones are interrupted over the third to the eighth segments. A black band borders the side of the anal plate and the first segment and crosses the side of the head; the three pairs of thoracic legs are glossy black, the others (prolegs) are whitish. The caterpillar and the moth into which it develops are shown in Figure 37.

In Professor J. B. Smith's recent Catalogue of the Noctuidæ of Boreal America, this and its allied species are referred to the genus *Hydrœcia.*

The example sent is darker colored than any I have previously seen, being almost black. It manifests nothing of the restlessness and apparent timidity of those that I have taken from burrows

The present attack is of entomological interest rather than of economic importance. It probably will not occur in sufficient number on the tassels to prevent or even interfere with the proper pollenization of the plants. In the pieces of the tassels sent, as showing the operations of the caterpillars, a few of the flowers (staminate) have been nearly consumed and others partly eaten into, but the resultant injury will be so slight that no anxiety need be felt, in this instance, on account of the presence of the caterpillar, and no remedy for it need be suggested. (*New England Homestead*, for July 13, 1889.)

The Cow-horn Fly in New York.

A letter received from Miss Drake, of Demster, Oswego county, in the latter part of August, of the present year (1891), announced the presence of this fly on farms in that locality. In addition to replying to her request for information, the following notice was sent to the *Oswego Times*, and was published in the semi-weekly edition, dated September 4th.

Hon. John A. Place:

Dear Sir: — I am sorry to be obliged to announce the advent in your county of a very injurious insect pest, which is destined to increase and do much harm to the dairy interest, whatever efforts may be made to arrest its spread. With timely warning, however, and a general effort to prevent the increase of the pest, its injuries may be materially lessened.

The newcomer is the cow-horn fly, *Hæmatobia serrata* R. Desv. Its introduction into your county is quite recent, and it was doubtless brought by one of your railroads—probably the R., W. & O., which traverses the northern part of your county, as it was reported to me under date of August 25th from a farm at Demster, through which the above-named railroad passes.

The fly is armed with a long, stout, sharp proboscis which it thrusts into the skin of the cattle where it is the thinnest and sucks the blood. In general appearance it resembles the common house-fly, but it is smaller and more closely allied to the biting fly, *Stomoxys calcitrans*, which appears in autumn and attacks animals and men, often entering our houses and inflicting a sharp, stinging bite through the stocking or elsewhere on the leg.

It was imported from France a few years ago, and was first noticed, in Pennsylvania, in 1886. For the past two years it has been abundant and troublesome in New Jersey. It occurs also in Delaware, Maryland, Virginia, and Ohio. In the early spring of this year it had extended into one of the southeastern counties of New York bordering on New Jersey.

Looking for its gradual spread through our State, I was greatly surprised to hear that it was present in large numbers in Oswego county. Although the account given me of its operations evidently pointed out the insect, yet I felt some doubt until, at my request, examples of the fly were sent to me.

Replying to a letter from Miss Drake, of Demster, who first informed me of the presence of the fly on their farm, I stated that if it was, as I supposed, the horn fly, it could be recognized by its congregating in large numbers upon the base of the horns. Answer was returned: "They annoy the cows by getting on their horns and between them, but can not say that they prefer those places, as sometimes it appears that they literally cover the entire body, especially on the back and shoulders. Our neighbors are all troubled with them, and all the cows are shrinking of their milk."

In a letter received this morning, I have intimation of the occurrence of the fly in Oneida county, and that it had made its appearance there a year ago.

It seems strange that interested parties will not at once send notice to the State entomologist of the appearance of any new insect pest, for if commenced in time, means may often be taken to prevent the spread, or rapid multiplication, of newly introduced insect pests.

Mr. A. J. Fly, of Delta, Oneida county, writes as follows:

> I write to you for information in regard to a fly, which made its appearance in these parts about a year ago, and is proving a source of much damage to the dairymen and of suffering to the stock. The fly has increased very fast and attacks the cattle in swarms, causing sometimes large, raw sores on the shoulders and by the root of the tail, and also by the navel. They also cover the horns at times. They apparently attack fat cattle as readily as those in poor flesh. White and light colored cattle do not seem to be as much attacked as the black or dark ones. On spotted cattle the flies are sometimes thick on the black spots, while there are hardly any on the white. The fly seems more hardy than our common one, and takes more to kill it. If there is anything that can be done to get rid of this plague, our dairymen would be glad to know it, and avail themselves of the information, that they may relieve their cattle which are suffering greatly day and night.

The injuries from the attack of this fly do not result in the death of the infested animals, as was first reported, but they occasion large sores upon the body in various places, and from the irritation and inflammation that the myriad flies cause, there follows a great falling off in the amount of milk given — variously estimated at from one-third to one-half. The cattle also lose materially in flesh.

In New Jersey it has been found that the fly was most troublesome in June and early July, and that after the middle of August it gave comparatively little trouble. But even if you are to escape from any serious further harm from it this year, you should do what you can to prevent its continued multiplication.

Knowing that the fly deposits its eggs in the fresh droppings of the cattle, and mostly during the night, and that it lives and matures therein, I would urgently recommend that every morning, in infested localities, these droppings be carefully and thinly spread in the fields, so that it may quickly dry. The eggs and the larvæ would die in the dry material and could not mature therein. Another method of killing the insect in its early stages, but perhaps not so good as the preceding, is to scatter lime over the fresh droppings. To prevent the flies from biting the cattle, I know nothing better than once a week going over the bodies with a sponge dipped in whale-oil in which some carbolic acid has been mixed, only applying it to the tips of the hairs. I have treated of this fly, and given figures of it, in my *Fifth Report on the Insects of New York*, 1889, pp. 220–227. Possibly you might make some extracts from this, which would be serviceable and interesting to some of your readers.

Very truly yours.

The following communication relating to the fly, containing further notes of distribution and other additional information, was made to the *Country Gentleman*, of September 10, 1891:

Three years ago, in the autumn of 1888, the serious injuries to cattle in New Jersey, from the immense number of this biting fly that gathered upon the backs and sides of cattle and sucked their blood, was noticed in several numbers of the *Country Gentleman*. As at that time it had extended southward and westward into Delaware, Maryland, Virginia, and Pennsylvania, it was thought somewhat strange that it had not been observed in New York. It is now known to have entered our State as early, at least, as the summer of last year, but no published record of its occurrence was made until the present summer, when Mr. J. D. Lyons of Monticello communicated to the June number of *Insect Life* the statement of its abundance at that place during the preceding autumn, and that it had been first observed by him about the middle of August. Monticello is in Sullivan county, in the southeastern part of the State, and about twenty miles north of the northern limit of New Jersey.

On August 24th of this year, I was surprised to have the insect reported to me from Oswego (on the southern curve of Lake Ontario), and so abundantly that on a farm at Demster they were literally covering the backs and shoulders of the cattle, annoying them greatly, and largely reducing the yield of milk. Upon looking at the location of Demster, it was found to be on the Rome, Watertown and Ogdensburg railroad, and it therefore seemed probable that the fly had been carried to that remote part of the State by railroad transportation, either upon cattle or in cattle cars.

The following day a newspaper item noted the presence of the fly on many farms in Caton, Steuben county, N. Y.—this county being at the middle of the southern tier, and the town of Caton, bordering on Pennsylvania, whence it had doubtless been introduced.

From the above known localities of this troublesome insect, there is every probability that it has already been, or very soon will be, largely distributed throughout the State of New York.

While it will not occasion the alarm that attended its first formidable attack upon the cattle in New Jersey—excited by the sensational reports that from the clusters of the fly upon the horns, larvæ were produced which burrowed into the head and brain, causing death within twenty-four hours—still, its injuries are of such a character that it is very desirable that proper effort should be made by every dairyman—first, to prevent the attack of the fly, which is followed by unsightly and unhealthful sores, and a diminution in the flow of milk from one-third to one-half: and, secondly, to reduce the number of the flies by preventing their breeding. It is not difficult to do this. While there are several greasy substances which, if applied to the cattle, will prevent the flies from alighting and inflicting their bites, it is thought that the best results have been obtained from the application, at least once a week, to the tips of the hair with a sponge, of fish-oil in which a little carbolic acid has been mixed. This has been found to give almost entire immunity from attack for nearly a week. Any application of tar to the horns is useless, as when gathered there the flies do no serious harm, having only selected a convenient resting place from which they may not be dislodged by the sweep of the tail, or by ordinary rubbing.

A knowledge of the breeding habit of the fly suggests a simple remedy available against its multiplication. The insect breeds in the droppings of the cattle. Its eggs are deposited almost wholly during the night in the fresh droppings; it has been stated that from their point of observation about the base of the tail, the flies follow the droppings to the ground, and at once deposit their eggs therein. For the hatching of the eggs and the development of the larvæ into the winged insects, moisture is required. If, therefore, every morning during the prevalence of the fly the droppings of the night be thinly spread over the field with a shovel, so as to permit its speedy and thorough drying, the eggs and the larvæ that may be therein will die from want of the proper moisture needed for their development. This method is so simple that no dairyman should hesitate to charge himself with its diligent performance. Another means of killing the insect in its early stages is said to be sprinkling lime over the droppings. While this does not seem as simple a remedy as the one before mentioned, it might be desirable for use in stables.

In the *Fifth Report on the Insects of New York*, 1889, several pages have been given to the life-history and habits of this insect (*Hæmatobia serrata*), its introduction from the south of France into this country, the character of its injuries, its distribution, together with some preventives and remedies which have not been named in this notice. A representation of the fly and its peculiar and formidable biting and sucking apparatus is also there given.

Professor John B. Smith, entomologist of the New Jersey Agricultural College Experiment Station, has given a bulletin (No. 62, November, 1889) of forty pages on "The Horn Fly," which is an interesting and highly valuable paper. It is possible that some copies of this bulletin are still to be obtained, and may be had upon application to Director James Neilson of the Station, at New Brunswick.

At the recent meeting of the Association of Economic Entomologists at Washington, D. C., the presence of this fly in Ohio was reported. Like most of the introduced European pests it will doubtless have an extended distribution throughout the States of the Union, and also a speedy one, from the ease with which it may be conveyed in cattle cars by rail.

Wire-worms and Remedies for Them.

Eds. Country Gentleman.— The wire-worms have become so plenty in this county that it is nearly impossible to raise a respectable crop of potatoes, corn or oats; they also work heavy on timothy meadows. All remedies applied so far have failed to do away with them. Could not some one of your readers who has experimented with them give us his views on this subject? M. L., *Potter County, Pa.*

Although I have not had the opportunity of experimenting with wire-worms, or of making special study of means for controlling them, yet the results of what has been done and reported by others, may be of value to the above inquirer, and to a host of others who are troubled with "the wire-worm"— one of the most annoying pests with which the agriculturist has to do.

Of the many methods that might be recommended for dealing with these insects, and for mitigating their ravages to a greater or less extent, the three following are named as probably the best and most efficient that may be employed:

1. *Starvation.*— When a crop is known to have been injured by them, upon the removal of the crop, collect thoroughly and burn all the material upon which the larvæ might feed another season, for the larval life is long-extended — it is believed, in most of the species, to three years, and in some, it is claimed, even to five years. If the ground has been cultivated for potatoes, or vegetables of any kind, gather in piles all the stalks, stems, or vines, together with the roots, and burn them. When timothy meadows, or grass lands of any kind, have been infested, after feeding as closely as possible, plow thoroughly and fallow — as also in the cultivated fields — during the autumn, with such additional plowings and harrowings as shall best tend to destroy all vegetable life. Gas lime, if procurable, may at this time, to great advantage, be spread upon and washed into the soil. Repeat these operations the following spring, and allow the field to lie fallow for the year. This will certainly arrest the wire-worm attack.

2. *Buckwheat Remedy.*—If the fallowing for the year be thought an unnecessarily high price to pay for the arrest of the injury, it may per-

haps be accomplished in this manner: After the ground has received the thorough breaking up and working over in the autumn and spring above recommended, follow with a crop of buckwheat. Wonderful efficacy has been claimed for this plant in freeing ground from wire-worms. Of the abundant testimony that might be quoted on this point, we will only give that of the late Hon. A. B. Dickinson, who has stated as follows:

"After experimenting with salt and lime, and many other things recommended, I have found only one remedy for the rascals, and that is to break the sod and sow it to buckwheat. Plow late, and as often as possible, in the fall, and then sow it to pease in the spring. With a like plowing the next fall, they will not injure any crop the following season."

3. *Mustard Remedy.*—In England a crop of mustard is regarded by many as an absolute specific against the wire-worm. In an address before an agricultural society there, the speaker, after narrating some successful experiments which he had made with mustard, on a small scale, made the following explicit statement:

"Thus encouraged by these results, I sowed with mustard the next year a whole field of forty-two acres, which had never repaid me for nineteen years, in consequence of nearly every crop having been destroyed by the wire-worm. I am warranted in stating that *not a single wire-worm could be found the following year*, and the crop of wheat throughout was superior to any that I have grown for twenty-one years!"

As possibly some of the readers of the *Country Gentleman* may not distinguish between the wire-worm, the cut-worm, and the "thousand-legged" worm, it may be desirable to state that the first-named is a small (usually less than an inch in length), slender, flattened creature, with shining surface, and often of a horn-color or pale brown or yellowish shade; its texture is tough and leathery. The first three segments of the body are each furnished with a pair of rather long four-jointed legs, while the last segment bears a single retractile proleg. Figures 38 and 39 are rude representations of two of the common species—Figure 38 being the *Agriotes mancus* of Say (regarded by Dr. Fitch as *A. truncatus* of Melsheimer), and Figure 39, *Melanotus com-*

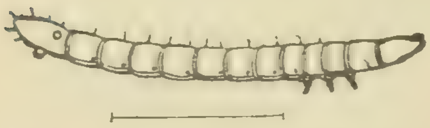

Fig. 38.—Larva of Agriotes mancus. (After Fitch.)

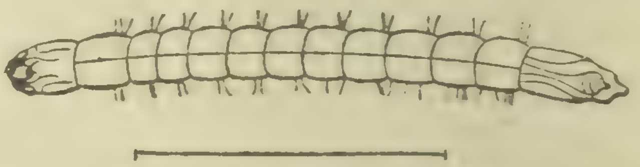

Fig. 39.—Larva of Melanotus communis. (After Fitch)

munis (Gyll.). The perfect insects into which they develop — known from their habit, when placed on their back, of springing into the air in order to regain their feet in the fall — as "snapping-bettles," are represented in part by Figure 40. Figure 41 shows, in enlargement, one of the wire-worms in the act of burrowing into and feeding on a kernel of corn. Figure 42 represents one of the common cut-worms, *Agrotis clandestina*, in the well-known curled attitude that it assumes upon being unearthed. Figure 43 is one of the thousand-legged worms — *Julus cœruleocinctus* Wood.

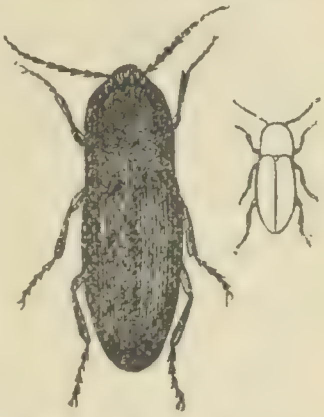

FIG. 40.— MELANOTUS COMMUNIS, natural size and enlarged. (After Fitch.)

The wire-worms — members of the family of *Elateridæ* — are very numerous in species, but the early stages and life-histories of but a few have been studied, and even those are imperfectly known. Their faithful study is a great desideratum, but unfortunately the difficulties that it presents has deterred most of our entomologists from its prosecution.

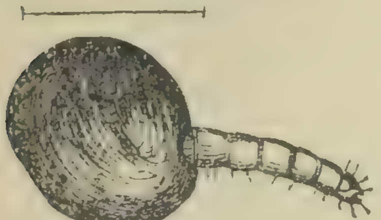

FIG. 41.— A wire-worm attacking corn. (After Fitch.)

The *Country Gentleman* has presented its readers with many excellent articles on wire-worms, remedies for them, etc., which may be consulted to advantage by those who are sufferers from their depredations. Among these, the following issues may be cited: May 8, 1877, p. 281; June 14, 1877, p. 377; August 5, 1877, p. 220; December 11, 1879, p. 793; February 8, 1883, p. 105; May 31, 1883, p. 441; November 29, 1883, p. 961; April 12, 1888, p. 284. There are also many others, which may readily be found by turning to the elaborate and careful indexes that accompany each volume.— *C.-G.*, November 29, 1888.

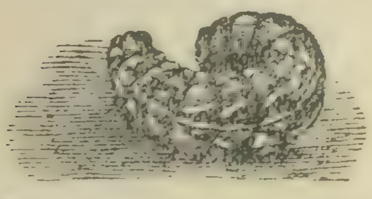

FIG. 42.— The w-marked cut-worm of AGROTIS CLANDESTINA.

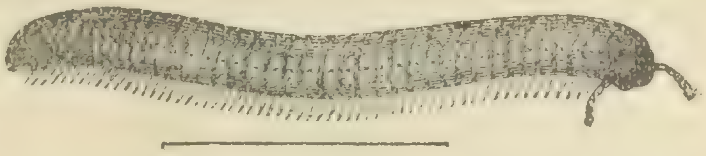

FIG. 43.— Thousand-legged worm, JULUS CŒRULEOCINCTUS Wood.

NOTE.—A careful study of wire-worms, extending over three years, has since been made at Cornell University, Ithaca, N. Y., by Professors Comstock and Slingerland, and the results published in "Bulletin 33 of the Cornell University Experiment Station," for November, 1891. The experiments conducted in the course of the study embraced trials with various insecticides for the destruction of the larvæ and beetles; killing the larvæ by fallowing, starvation, growth of the supposed immune crops; protection of seed by tar coating, and soaking in kerosene, salt and copperas, and other solutions; the effects of certain fertilizers; methods of destroying the pupæ and beetles, etc., etc.

The experiments in remedies and preventives against the larvæ gave no satisfactory results or such, at least as seemed to be of practical importance in preventing to any great degree their ravages. It appeared as if the efforts of the agriculturists could be directed with better results toward the destruction of the beetles.

The Bulletin closes with the life-histories and larval descriptions of five species of our wire-worms, viz.: *Agriotes mancus* (Say), *Asaphes decoloratus* (Say), *Melanotus communis* (Gyll.), *Drasterius elegans* (Fabr.), *and Cryptohypnus abbreviatus* (Say),— covering twenty-two pages, which are of special value in consideration of the comparative little study that has, up to the present, been given to this family, and its great economic importance.

THE ROSE BUG AND HOW TO KILL IT.

The following notice was communicated to the *New England Homestead*, of May 9, 1891 (vol. xxv, p. 265), in compliance with a request from the editor: "Will you please tell our readers how to kill the rose-bug?"

There are localities as notably in the State of New Jersey, where the grape crop can not be protected from destruction by the rose-bug. This insect has its breeding ground in wet places in sandy regions. Under favorable conditions these breeding grounds, in the course of years, become so extended that at a regular period, known almost to the very day (about the 25th of May in New Jersey), such immense armies are sent abroad, that their combined attack is perfectly irresistible. Although hundreds of thousands may be killed, yet as fast

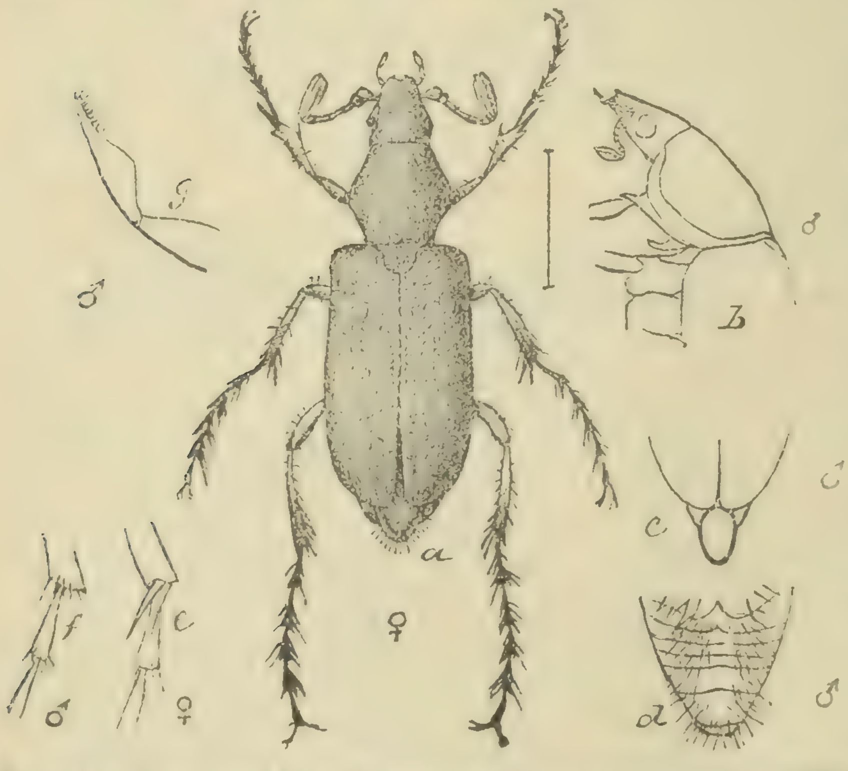

Fig. 44.— The rose-bug, Macrodactylus subspinosus, with structural details. (From *Insect Life*.)

as destroyed others take their place, until the crop they attack is entirely consumed. Contest with them is hopeless, and may as well be abandoned at the outset, so far as the preservation of the crop is concerned.

Usually in the New England States and in New York, the beetle does not appear in irresistible numbers, and is within our control. Often this can be accomplished by beating the insects from the plants, at intervals during the day, for perhaps a week or two, into a pan of water and kerosene. When occurring in still larger numbers, severe injury from them may be prevented by repeated sprayings with kerosene emulsion. The efficacy of this method is attested by Professor M. H. Beckwith, in Bulletin No. 12, for March, 1891, of the Delaware Agricultural Experiment Station. Prof. Beckwith first tried spraying grapevines, upon the blossom buds of which the beetles had commenced to feed on the 27th of May, with London purple of the strength of one pound to two hundred gallons of water. The beetles were entirely unaffected by the arsenite, and not a single dead one could be found as the result.

The vines were next sprayed with a mixture of lime and water, completely covering with it the foliage and blossom buds. This application at first seemed to be distasteful to the insects, and checked their feeding for awhile, but in a few hours they resumed their attack, and completed the destruction of the buds.

The next experiment was made with kerosene emulsion. This was entirely successful. Rose bushes thronged with the beetles were sprayed with an emulsion of one part of kerosene to nine of water. When the spray struck the beetles they at once fell to the ground. The application was made in the evening, and the following morning many of the dead beetles were lying on the ground underneath the bushes. Several of the sprayed roses containing many of the beetles were picked off and placed in a well-ventilated breeding cage, and in the morning every beetle was dead. It should be borne in mind that the emulsion kills only by contact, and that therefore successive applications of it must be made as often as the beetles reappear upon the plants. It seems to kill all the insects that it reaches.

Another remedy for this most pernicious insect is found, upon the testimony of Professor J. B. Smith, of the New Jersey Agricultural Experiment Station, in the sludge-oil soap, manufactured by the Columbia Chemical works, at Brooklyn, N. Y. It was tried upon the beetles, when appearing in full force in New Jersey, after everything else that had been used — perhaps twenty different insecticides — had entirely failed. The sludge-oil soap was the only material that would conquer these insects, in the experience of Professor Smith. Col. Pearson, of Vineland, who has so long and faithfully been experimenting with methods for controlling the rose-bug, also had most gratifying success in the use of this valuable insecticide. It therefore appears, that in the use of kerosene emulsion and sludge-oil soap, we have two reliable insecticides with which we are able to control the ravages of this pest of the horticulturist and fruit-grower, whenever it does not appear in overwhelming numbers. In New Jersey, a successful fight against it can only be made in the discovery and breaking up of its breeding grounds.

In *Insect Life*, ii, March, 1890, pp. 295–302, Dr. Riley has given a quite full account and excellent figures of this insect. The figure illustrating the beetle is given herewith: the details of structure will be readily understood without special reference to them.

Professor Smith has also given in Bulletin 82, July 3, 1891, of the New Jersey Agricultural Station (40 pages, 10 figures), and in the Annual Report of the Station for 1891, an excellent account of "The Rose Chafer or Rose Bug," containing many new observations, and detailing, in 22 pages, the numerous experiments made by him for its destruction or prevention of its ravages.

THE MAPLE-TREE BORER, GLYCOBIUS SPECIOSUS (Say).

From Mr. Henry Herrick, of Amsterdam, N. Y., the following inquiry was received, dated Sept. 23d, 1891:

> Grubs or worms are destroying my maple shade trees. They either work around the trunk under the bark, or in an upward direction for a yard or more and then go into the wood to the depth of four or five inches. I have had a man to cut out the dead bark and trace them to the hole, where I can insert a stick in many cases for five inches. I would like to know what I can put in the hole to kill the grub without harm to the tree. A stick or a wire may fail to reach him in the burrow from its not being straight. Can I throw something in with a syringe that will do the work?

Mr. Herrick was answered: It will not be worth your while to attempt to kill the grubs in your maples by injecting an insecticide. The long burrows contain no grubs, they all having emerged from the trees through holes in the bark in July. At the present time all of the grubs are within easy reach of your knife. Their location in the tree, if you will go carefully over the bark, may be discovered, as Dr. Packard has told us, by "a rusty, irregular discoloration of the bark of about the size of a cent, and especially by the frass or castings, which, to the length of an inch or more, are attached, like a broken corkscrew, to the bark."

On cutting into the bark at this place you will find the slender burrow, probably running in an upward direction for about an inch, and the young grub, of about one-fourth of an inch long, lying in its upper end.

This is the most simple and effective way in which to arrest the injuries of this destructive borer. It is far preferable to wrapping the trunk with cloth during July or August, or applying repellants for preventing the deposit of the eggs, for, by the means above suggested, the insect is killed instead of being driven away to other trees.

The following notice of this insect is contained in the "Report of the State Entomologist to the Regents of the University of the State of New York, for the year 1886," but as only a few copies of this paper were printed for distribution it is republished here, containing as it does, some observations that have not been given elsewhere.

A lady writing from Canajoharie, New York, complains with much feeling of the ravages of a borer which is rapidly destroying some highly valued maples which shade and adorn her home.

From the account given of its operations, it is undoubtedly the maple borer above named (*Glycobius speciosus*), which was first described by Say in 1824, in *Long's Second Expedition to the Sources of St. Peter's River* (ii, p. 290), as a rare insect. In addition to the specimen taken on the Wisconsin river during the expedition, one other only was known, which had probably been taken in Pennsylvania, and was in the possession of the Philadelphia museum. It was subsequently illustrated in Say's *American Entomology*. Dr. Harris has noticed and figured it in his *Insects Injurious to Vegetation*, giving at the same time one of those popular and graphic descriptions which enable his readers to recognize the insect unaided by illustration, and have lent such a charm to his invaluable report. Of later years the beetle has become comparatively abundant, being found in nearly all collections, and having been frequently written of by a number of authors. It is one of our most beautiful species, as its specific name of *speciosus* (meaning beautiful) implies, being a member of the family of longicorns (*Cerambycidæ*) and measuring over an inch in length, marked with the strongly contrasting colors of yellow and black, and bearing conspicuously a w-like character on the front part of its wing covers. [See Figure 45, reproduced from Emmons.]

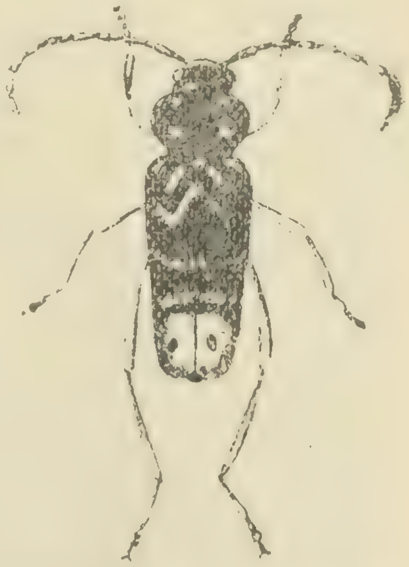

Fig. 45.—The sugar-maple borer, Glycobius speciosus.

Despite its beauty, it is a highly pernicious insect. Not content, as are most of its associates, with burrowing in dead or sickly vegetation, its attack is usually made on perfectly healthy trees.

It was my privilege several years ago to follow an attack of this insect on a row of maples at Schoharie, New York, which I passed daily, and had for years observed with pleasure their vigorous and healthful growth. As adding to the testimony of Dr. Packard of the attack of healthy trees (*Insects Injurious to Forest and Shade Trees* — Bulletin No. 7 of the United States Entomological Division, pp. 103, 104), I herewith copy the record made under date of November 30, 1859:

> I have noticed this autumn, for the first time, that our sugar maples, which we have always regarded as our most valuable shade tree, from the almost complete immunity which they have enjoyed in trunk and leaf from insect depredation, have been attacked by a borer so pernicious in its work as to threaten their destruction unless some means shall be found to arrest the attack.
>
> In its simplest form it reveals itself by the bark parting longitudinally and breaking away, disclosing the wood of the tree in a narrow strip for some five or six inches in length. On the surface of the wood can be seen the furrow of the grub, cut to a slight depth, gradually increasing in its dimensions as it descends, and at the lower end entering the trunk of the tree: over the borders of the groove the growth of sapwood made since the injury, impinges. This, I presume to be the work of a grub proceeding from an egg deposited late in the season, and compelled to seek an early refuge by approaching winter. A wound no more serious than this, would close over in two or three years and no permanent injury result. But when the grub has had full time allowed it for its work the injury is far more important.
>
> In several instances I have traced the furrow, packed tightly with fine powder for two feet or more in extent, with an average breadth at its lower portion of over half an inch and nearly one-fourth of an inch in depth. To render it the more serious the grub, almost invariably before entering the tree, leaves its downward path and winds nearly horizontally around the trunk until it completes about half a circuit. It then enters the trunk an inch or thereabouts back from the end of its burrow, ascending at an angle of about ten degrees. The perfect insect emerges from the tree above its point of entrance through an opening which can be probed horizontally for three or four inches, the mouth of which is smoothly cut and somewhat elliptical, the broadest diameter being about .35 of an inch.

One maple which I have examined, of about ten inches in diameter at the base, which has been more seriously affected than others, and probably the first to be attacked, has been nearly destroyed. Several of the grubs had commenced their ravages side by side, and by their united cuttings have in places exposed the trunk for over a hand's breadth The tree has been attacked in various places from above its first limbs nearly to its base,— the injury extending beneath the surface of the ground. The entire circumference of the tree has been grooved, although not continuously. Circulation is still maintained by winding around and among the furrows; but one more season's work will, it is believed, take the life of the tree

In a row of maples bordering a lawn scarcely a single tree is entirely exempt from injury — all apparently the work of this grub. If these injuries are to continue and increase, and I see nothing to prevent it, our maples, which we prize so highly, will share the fate of the locust and be abandoned to the borer as too unsightly a tree for ornamental use.

The "beautiful Clytus" is a difficult insect to control, and very many of the fine old maples, which have ornamented our streets and afforded us so agreeable shade, have been or are being killed by it. A few years ago it was a source of much pain to me to see at Bennington, Vt., the large number of old maples that were standing dead upon the streets or rapidly dying from the merciless burrowing of this borer that had scarred and excavated their trunks. Recently the same ravages, although not as yet to the same extent, were observed by me at Glens Falls, N. Y.

Probably the best method of arresting the ravages of this pernicious borer would be to watch for the commencement of the operations and kill the young larva. The eggs are laid in July and August. [The means communicated to the lady for finding and killing the borer were virtually the same as those given in the reply to Mr. Herrick, and therefore need not be repeated here.]

THE SQUASH-BUG, ANASA TRISTIS (De Geer).

A correspondent desires to know what is best for the destruction of the black squash-bug, *Anasa tristis*. Can Paris green be used with safety? If not, what can be used quickly and safely on an acre or two of squashes?

Paris green is of no service against the squash-bug, or the many other bugs of the Order of Hemiptera that take their food through a proboscis from the interior of plants. The best remedies, so far as known at the present, for the squash-bug are found in trapping and killing the females before their oviposition, and in the destruction of the eggs. Some success has attended experiments made for preventing attack, by the employment of strong-smelling substances, as for example, dipping corn-cobs in gas-tar and thrusting them in the ground among the plants, and occasionally renewing the tar.

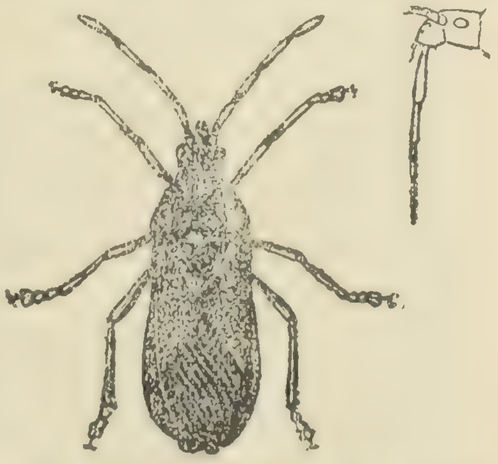

FIG. 46.—The Squash-bug, ANASA TRISTIS — enlarged one-half diameter; head and beak still more enlarged.

The first appearance of the bugs among the plants should be watched for, that operations against them may be promptly commenced,— or what may be still better, traps should be arranged for them a little in advance of their expected time of coming. In the Northern States they generally come abroad from their winter hiding places toward the latter part of June. The traps may be pieces of bark, chips, bits of wood or strips of board, laid upon the ground near the hills. It is claimed, by some that the best possible trap is found in the leaves stripped from the lower part of the plants and spread beneath, as the insects are particularly fond of the juices of the wilted foliage. The traps should be turned over and examined morning and evening, and the bugs which have hidden beneath them for the day (coming abroad at night for the deposit of their eggs), captured and destroyed.

In addition to the daily examination of the traps, careful inspection should be made of the underside of the lower leaves for the patches of eggs that may be deposited on them, which when found are to be crushed. The eggs may be recognized by their being of a dull orange color, flattened on their two sides, and occurring in clusters. As the female does not deposit all of her eggs at once, and as fresh bugs continue to make their appearance for the space of two or three weeks, the daily search may be advantageously continued for that length of time and as much longer as the life of the ovipositing female is extended beyond it.

Later, while searching for the eggs, companies of the young squash-bugs will be found on the leaves, each with a green body, the head and thorax black, and the antennæ pink. When two or three days old, the color of their body changes to ash-gray, and the others portions to black.

The employment of the above remedies involves considerable labor, but where the insect is unusually numerous, it will be amply repaid. If commenced in season and faithfully continued into July, much of the accustomed damage of the notorious pest, will be prevented, and but few of the mature forms with their increased power for injury will be found during the months of September and October.

Care should be taken not to permit the bugs to gather around the base of the main stalk, as they are sometimes wont to do (for sucking its juice) in such number as to girdle it. This may usually be prevented by drawing away some of the ground from around the stalk and applying a mixture of dry ashes and salt. Without this precaution, it is said that the bugs will at times burrow into the ground out of sight where they feed securely and unsuspectedly on the sap of the plant. High fertilization, will of course, assist materially in the ability of the plants to resist the attack made upon them by this pernicious insect. (*Country Gentleman*, for January 8, 1891.)

THE HOP-VINE APHIS AND REMEDIES.

At the request of the editor of the *New England Homestead* for an article upon the best methods known for controlling the hop-vine aphis, the following notice was communicated, and was published in the issue for May 2, 1891. It was copied in a number of other papers in the hop districts of the State:

The one great uncertainty in the successful cultivation of the hop crop is its liability to attack and destruction by the hop-vine aphis — sometimes known as "the fly" or "the green fly." Although this insect is not entirely absent from our hop yards in any year, yet its multiplication and the excessive injury that it frequently inflicts is dependent upon atmospheric and meteorological conditions. Unfortunately these can not be predicted, and, therefore, the hop-grower usually defers action that would serve to prevent aphis multiplication until the attack has been made in force — can not be wholly arrested, and can only be mitigated at a great expense.

Hop-vine Aphis in Europe and America.

The hop-vine aphis, *Phorodon humuli* (Schrank), is an European pest, which was first observed in the United States in 1862. For a long time it has been allowed to work its ravages in this country, in years of its abundance, without effort made against it. Quite different has been the course pursued in England, where no hop-grower attempts to grow a crop without his regular "hop-washings."

Its Life-history Discovered.

Four years ago (in 1887), the life-history of the insect was, for the first time, worked out, in the hop yards of New York, by the entomological division of the U. S. Department of Agriculture. With this knowledge at our command, it is safe to say that, *with proper care and without great expense, our hop crops can be saved from aphis destruction.*

The insect, deserting the hop yards in the autumn, passes to plum trees, on the smaller twigs of which its eggs are laid and survive the winter. Hatching in the early spring [and producing the "stem-mother," shown in Figure 47], three broods are developed on the plum, the third brood being winged. This brood at once takes wing, deserts the plum trees, and flies to the hop yards. This flight takes place *in the month of May*—in England it has been noticed on the 28th of May. The precise time would, of course, vary with the temperature of different seasons, but could be ascertained by a careful examination of the hop leaves daily at about the usual time for its appearance.

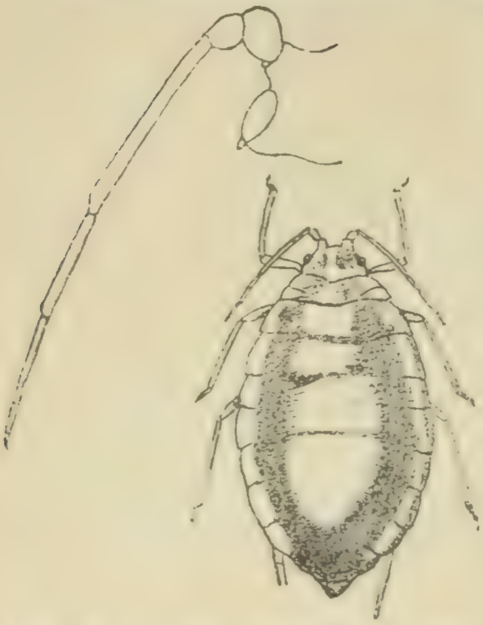

Fig. 47.—The hop-vine aphis, Phorodon humuli, the stem-mother, enlarged; head and antenna still more enlarged. (From *Insect Life*.)

When to Attack the Aphis.

The winged aphides [the "migrants," shown in Figure 48] would be found at first *on the upper leaves of the outer rows of plants in the yard.* This is the time, without any delay, to commence operations against them. They should be killed, and thereby prevent the enormous progeny to which they would give rise in the nine rapidly succeeding generations said to have been observed on the hop-plants. This multiplication, in favorable seasons, is simply appalling — almost incredible, but it need not be permitted.

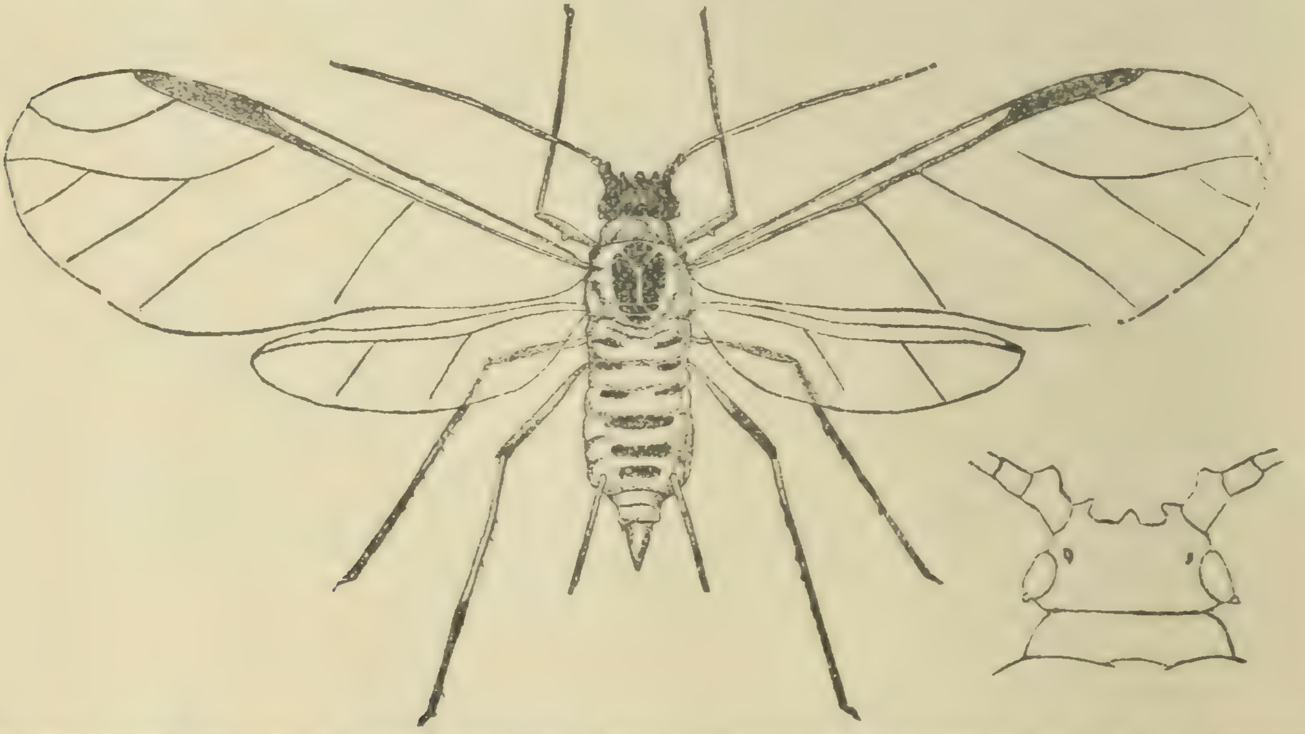

Fig. 48.—The hop-vine aphis, Phorodon humuli, migrant from plum, of the third generation, enlarged; head still more enlarged. (From *Insect Life*.)

It may be prevented by ***killing the plum-tree migrating brood while upon the outer rows of the yards.***

How to Kill the Aphis.

The best insecticide for use is believed to be kerosene emulsion, prepared after the formula which has been so often given in leading agricultural journals.

The emulsion is made as follows: Take of kerosene, two gallons; common soap, a half-pound; water, one gallon. Dissolve the soap in the boiling water, and, after removing from the fire and while yet boiling, add the kerosene, emulsifying the mixture by pumping it through a force pump with a spray nozzle into the same vessel until it assumes the appearance of thick cream and the oil does not rise to the surface.

For ordinary use, on trees, etc., dilute the above mixture with nine parts of water.

For the hop-vine aphis one part of the emulsion to twenty-five of water should be used, as a greater strength is liable to blacken and injure the leaves.

Properly applied, by spraying with a suitable force pump through a fine nozzle, it will not fail of killing every aphis with which it comes in contact. It is all important that it be applied so as to bring it in contact with each insect, as it kills only by this means, and not, as do the arsenical mixtures, by depositing the poison on the leaves to be subsequently eaten by the insects. All plant-lice are sucking insects, feeding only on the sap of the vegetation that they infest.

As the kerosene emulsion requires some labor in its preparation, possibly some of our hop-growers would prefer to use the hop wash which, for a long term of years, has been successfully used by the English hop-growers, and we accordingly give the formula for it:

One hundred gallons of water (if hard water, with soda added).

Four to five pounds of soft soap.

Six to eight pounds of quassia chips, first steeped in cold water and afterwards steamed or boiled.

The efficacy of this washing has been clearly demonstrated. Hop-growers who have sprayed with it in England have grown crops of 700 to 900 pounds per acre, while those not using it grew nothing, or next to nothing.

Repeat Spraying as Often as Necessary.

As the plum tree brood does not migrate *en masse* at the same time, a second spraying should follow the first in a few days thereafter. Watch should be kept for the advent of newcomers, either through flight or by reproduction, as the new broods occur at intervals of a few days, and are therefore frequent during the season. The spraying should be repeated as often as is necessary to prevent the multiplication which would otherwise destroy the crop.

Preventives of Hop-vine Aphis Attack.

There are at least three methods by which much may be done to prevent attack:

1. Cut down and burn all the wild plum trees in localities where hops are grown, so as to afford fewer places where the hop-vine aphis may oviposit in the autumn. Include in this such cultivated plum trees as are not yielding paying crops, particularly if infested with black-knot.

2. Spray all cultivated plum trees with a strong kerosene emulsion during the winter, or in the early spring before the leaves are out, in order to destroy the eggs of the hop-vine aphis which may have been deposited there the preceding autumn. The kerosene should penetrate and quickly kill all the eggs which it reaches.*

3. Collect and burn all the refuse (leaves and vines) of the hop-yard as soon as the crop is picked. At this time many of the male aphides, which are the last to leave the yard, are still upon the vines, and in the burning, it is believed, that their number may be reduced to the extent that enough will not remain to fertilize all the females that have already taken their departure. The mating occurs largely, if not wholly, upon the plum trees.

The above directions involve watchfulness and labor, but the demand they make is trifling in comparison with the value of the crop that may thereby be rescued from destruction.

The figures in the above are from the Entomological Division of the U. S. Department of Agriculture, obtained through the kindness of Dr. Riley.

THE MELON APHIS, APHIS CUCUMERIS Forbes.

LOWELL, MASS., *August 27th.*

EDS. COUNTRY GENTLEMAN.— I send you by mail a box containing some muskmelon leaves and shoots that have been attacked by what seems to be a kind of plant-louse. Last season they destroyed my little plat when the melons were half-grown, the vines appearing as if touched by frost. Can you tell me what the creature is, and what means could be used as a preventive? I presume that it is too late now to save the vines, though I did not notice any trouble until yesterday.— T. C. B.

The aphides or plant-lice, from the fortnight's delay in reaching me, had become shriveled and discolored, but there is scarcely a doubt that they are the species which was described and named by Professor Forbes,

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* Late experiments have shown it to be doubtful if aphis eggs can uniformly be killed by spraying with the emulsion. It would certainly be effective if made to reach the young aphides soon after their coming from the egg.

State Entomologist of Illinois, as *Aphis cucumeris*, and was treated of by him at considerable length (nine pages) in the *Twelfth Report on the Insects of Illinois*, published in 1883.

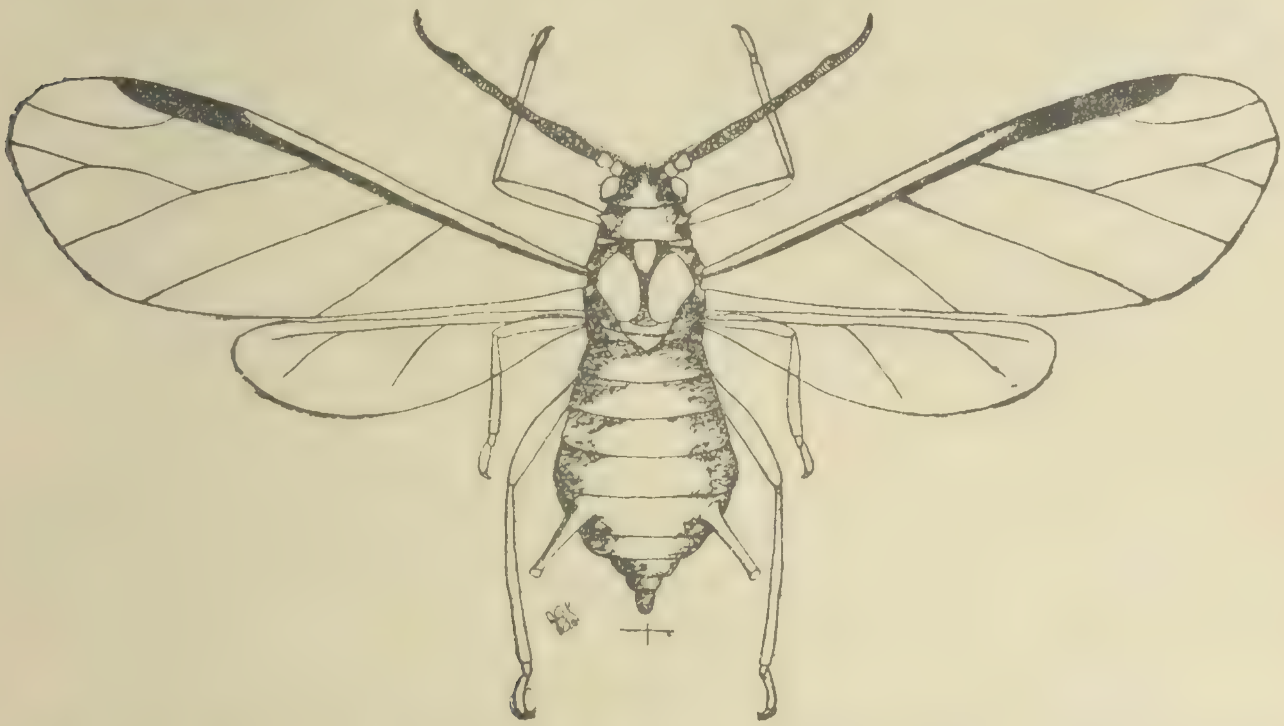

FIG. 49.—The melon aphis, APHIS CUCUMERIS, winged oviparous female. (After J. B. Smith.)

It is there characterized as "a minute, very sluggish, green or greenish-black insect, occurring in immense numbers from spring to late summer, on the underside of the leaves, and also upon the roots of muskmelons, cucumbers, squashes, and other cucurbitaceous plants, causing the leaves to curl and shrivel and lose their color, and greatly hindering the development of the plants."

It further appears, from Professor Forbes' account, that it was first observed in Illinois, in 1880, as doing much injury to nutmeg and muskmelon vines, and also to the cucumber vines. Early in the spring of 1882 it made an overwhelming attack on both watermelons and muskmelons, in many localities in Illinois, entirely killing the plants. Cucumber vines growing in the vicinity were not greatly injured; squash vines to a slight extent.

In some instances, where the vines were not at once killed by excessive numbers, the plant-lice disappeared from them about the 1st of August, permitting the plants to rally somewhat and yield a partial crop. Many of the insects had been parasitized, and their dead bodies, by thousands, were found clinging to the leaves.

This insect has not, so far as we know, been previously reported from the eastern part of the United States. It is to be hoped that in its presence here it may be met by the same parasitic attack that checked its increase at Normal, Illinois. The operations of the parasite — a minute insect that deposits its eggs within the plant-louse — may readily be recognized by the aphis becoming greatly swollen in size and rounded, and changing to a pale brown color.

In the absence of parasitic attack, Professor Forbes, as the result of experiments, recommends the following:

Sprinkling the underside of the leaves with road dust. In experiments, where it adhered, the insects were killed, or disappeared.

Dusting the underside of the leaves by means of a powder bellows, with pyrethrum powder. After twenty-four hours all the insects had fallen from the leaves, and were dead and dried up.

Spraying with a kerosene emulsion killed all it reached, and cleared many leaves entirely.

Tobacco smoke, forced by means of a common bee-smoker, under large pieces of canvas (hay-caps) covering a section of the plants, and keeping the space beneath well filled with smoke for ten minutes, killed seventy-five per cent of the insects.

For garden use, where the plants are comparatively few, the last-named remedy is deemed the most feasible.

It is advisable whenever this attack occurs, to destroy the old vines and leaves, within which the insect may be hibernating, and not to grow the same crop on the same ground the following season.

The muskmelon "shoots" submitted, show a different and a quite interesting form of attack, in which the smaller leaves have been transformed into small, irregular, subovate, downy galls. These have given out their insects, which are found to be a species of *Cecidomyia.* As I can find no mention of *Cecidomyia* attack on any of the *Cucurbitaceæ*, the insect is probably new to science. If it proves to be so, it might appropriately be named *Cecidomyia cucumeris.* It will be noticed hereafter. (*C. G.*, for September 27, 1888.)

MELON AND STRAWBERRY PESTS: APHIS CUCUMERIS AND CORIMELÆNA PULICARIA.

EDS. COUNTRY GENTLEMAN.— Be kind enough to inform me how to prevent lice from eating cantaloupe or cucumber vines; and, if spraying will do any good, what to spray with to destroy the insects and not injure the vines. There is also an insect that stings the stem of strawberry blossoms about half an inch from the carp; then they dry up and fall off. Is there anything to prevent this?

H. H.

Wellham's Cross Roads, Md.

The "lice" infesting melon and cucumber vines are probably the cucumber aphis, *Aphis cucumeris* Forbes. It may be killed if kerosene emulsion, pyrethrum powder or pyrethrum in water, fish-oil soap, or strong tobacco water, is applied to it. But as it usually occurs on the underside of the leaves, and causes them to curl irregularly, it is almost impossible to reach the insects by ordinary spraying. If a knapsack pump, provided with a rod and a Vermorel nozzle, be used, the liquid could be thrown very effectually upon the lower surface of the leaves. The eggs of this aphis are deposited in the autumn, and probably on the dead leaves and vines. If these, therefore, are collected and burned each year, the attack of the insect would be largely prevented.

The insect that punctures the blossom-stems of the strawberry is probably "the flea-like negro-bug," *Corimelæna pulicaria* Germ. (If possible, examples of insects of which information is desired, should be sent with the inquiry.) It is the size of some of the flea-beetles — about one-tenth of an inch long, and is shining black with a white stripe on each side. As this little bug has a large number of food-plants, as the raspberry, cherry, quince, garden flowers, and several weeds of which it is very fond, it is difficult to bring it under control. The same substances recommended above for the aphis would probably kill it.

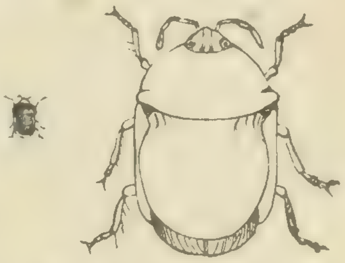

Fig. 50.—The flea-like negro-bug CORIMELÆNA PULICARIA. (After Riley.)

[The insect is shown in Figure 50.]

Professor Riley states that this troublesome and destructive insect is particularly partial to two weeds, upon which it breeds, and beneath which it may often be found in the month of June in countless numbers — viz., the red-root or New Jersey tea-plant (*Ceanothus americanus*), and neckweed or purslane speedwell (*Veronica peregrina*). He therefore advises the propagation of a small plat of either of these weeds near a strawberry patch or other infested crop, as a decoy for the bugs, which may thus be drawn away from the cultivated crops and easily destroyed when congregated in large numbers in a limited space. (*C. G.*, for June 4, 1891.)

Since the publication of the preceding notices of the cucumber aphis, Professor J. B. Smith has reported its destructiveness to all kinds of cucurbitaceous vines in all parts of the State of New Jersey, in 1889 (*Bulletin* 72, *October*, 1890, *N. J. Agr. Coll. Exp. St.*), and in the Annual Report of the Station, 1890, page 484, he refers to it as having been troublesome to growers for years past.

Professor Smith recommends as the best remedy for this insect, and a preventive of all injury if applied in time, fish-oil soap in the proportion of one pound to eight gallons of water, put on with the cyclone or Vermorel nozzle.

Scale Insects on Camellia and Oleander.

A lady has sent the following inquiry of scale insects which are infesting her plants in Jacksonville, Ala. Reply was sent through the *Country Gentleman* of March 25th, 1891.

> I inclose two leaves, one of *Camellia japonica*, the other of oleander, both of which are infested with parasitic fungi. The disease spreads over the plants, which alternately succumb to its attacks, in the greenhouse as well as in the open air. Will you kindly inform me what it is, and if there is any known means of its prevention.

The leaves give no indication of fungus attack (upon the authority of State Botanist Peck), but are infested with scale-insects. The oleander shows on its underside, along the midrib and scattered over its surface, numerous small, rounded white spots of about one-twentieth of an inch in diameter, having a wrinkled, pale orange center. These are the common "oleander scale," *Aspidiotus nerii* Bouché, which occurs over the whole of the United States and in Europe, and on a great

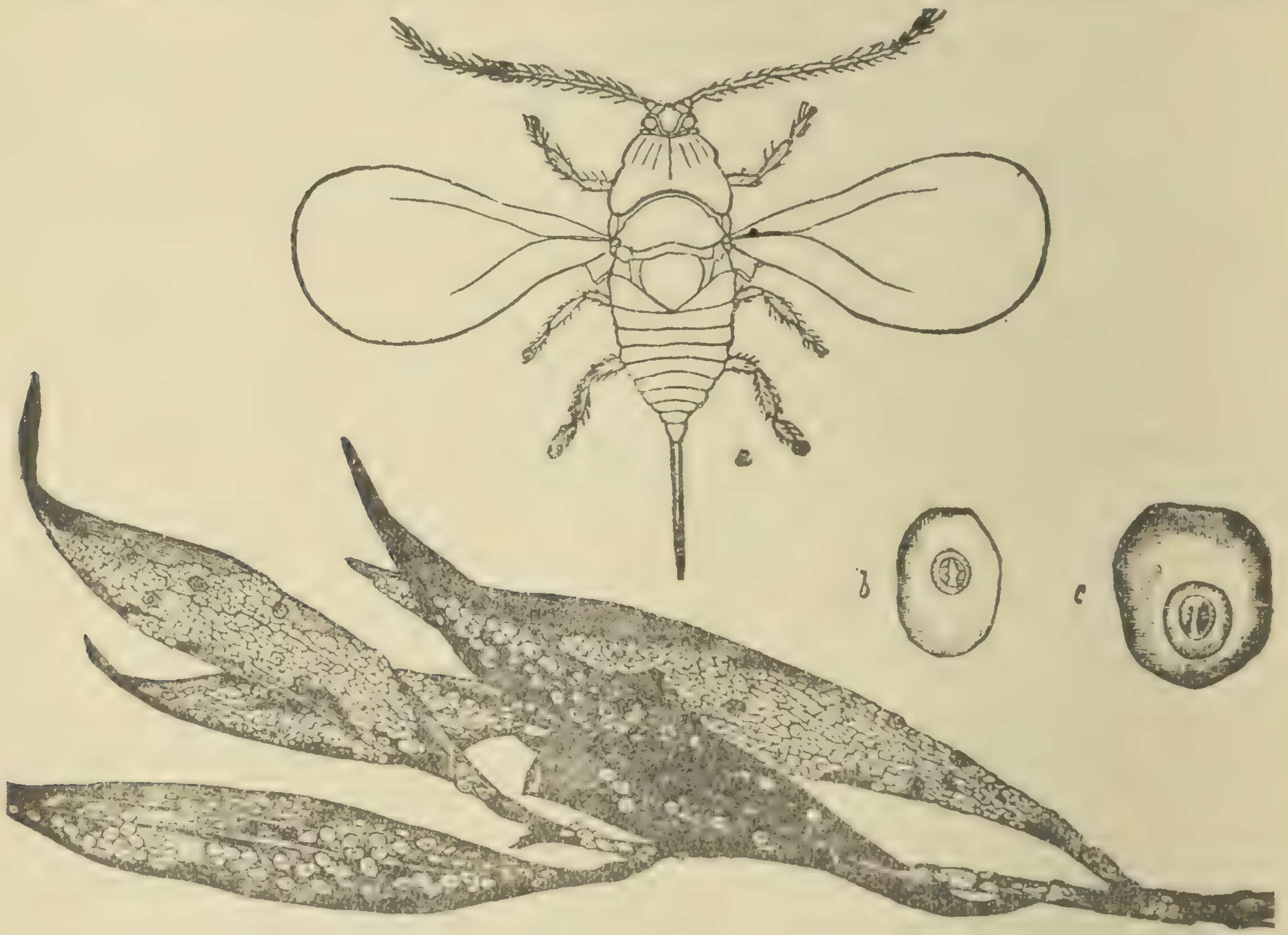

Fig. 51.—The white scale, ASPIDIOTUS NERII, on an acacia twig; *a*, the male insect; *b*, the male scale; *c*, the female scale—each enlarged.

variety of plants and trees, viz., magnolia, acacia, ivy, maple, plum, cherry, currant, orange, lemon, etc. The true insect, when mature, is found beneath the scale—the white portion of the scale being a protective secretion thrown out by the larva, having upon its center one or two orange-colored larval skins cast off at its moltings. [See, also, *Fifth Report on the Insects of New York*, pp. 278, 279.]

The camellia leaf is infested with a different species of scale. It is brown, elongate, bearing the cast skins upon its pointed and narrow end, quite broad at the other extremity (which in one example is white), and resembles in shape the well-known oyster-shell scale of the apple tree, except that it is not curved. It apparently belongs to the genus *Parlatoria.*

An assured remedy for these insects is spraying them with the kerosene emulsion or whale-oil soap solution. The latter might not be effectual except when applied to the young soon after they have hatched from the egg, and before they are protected beneath their scale. When infesting house-plants, as oleander and camellia, the insects may be destroyed by passing over the stalk and branches, and the leaves on their underside, with a sponge or piece of flannel dipped in a little sweet oil or kerosene. The oil will penetrate the scale and kill the insects beneath. Upon some old oleanders which had become badly infested through neglect, kerosene was used so freely that misgivings were entertained of the result, but the effect was only beneficial.

A Grapevine Scale Insect, Lecanium sp.?

Complaint was made that a grapevine which trails against a shed in Springfield, Mass., was covered with a multitude of scale-insects, similar to the specimens sent. The vine had not been so infested before, and another vine near by was not infested.

The piece of vine is almost entirely covered with the large scales of this insect — in some cases even overlapping one another. They are of a dark mahogany color. A few are of a pale brown color, with two broad subdorsal blackish stripes and about eight narrower transverse bands. They are smooth and without a carina, broadly oval, their dorsal elevation about one-half of their diameter, and the largest measure one-sixth of an inch in length. On raising the scales from the bark they were found to be packed with small transparent white eggs, elliptical in form, with a length of about double their breadth. These scales are identical with some described by me in the *Country Gentleman* for July 4th, 1878, and not identified at the time.

Associated with the above are some smaller pale brown, more elongate scales, which in their carination and transverse constrictions bear resemblance to *Pulvinaria innumerabilis* [Rath.], while they are evidently a species of *Lecanium*. A few of the eggs have hatched at this date (June 4th), and the young larvæ are running rapidly over the scales. No cottony secretion is present, but when the scale and eggs are brushed away, a white powdery substance is found beneath them.

As, on a former occasion, I have counted 1,054 eggs beneath one of these scales, the rapid rate at which the insect may multiply, is evident. It will be necessary, therefore, to free the infested vine from them, or they will speedily destroy it and extend to other vines.

If the scales are confined to a portion of the vine, they could be removed from it at the present time and many of the eggs destroyed by crushing them with a cloth held in the hands and moved over the stem with a twisting motion. The cloth might be wet with a carbolic acid solution or strong soap suds; or the scales could be scraped from the vine with some blunt instrument and received in a broad basin of water covered with kerosene. The eggs should by no means be permitted to survive the operation of their removal, to continue the attack and destroy the vine, as they undoubtedly would if not properly treated. With the eggs hatched, the empty scales, it is hardly necessary to add, would be harmless. (*New England Homestead*, June 12, 1886.)

APPLE-TREE INSECTS OF EARLY SPRING.

Apple-tree Aphis — Apple-tree Case-bearer — Eye-spotted Bud-moth — Apple-leaf Bucculatrix — Pear-tree Psylla.

Insect attacks upon the unfolding buds of the apple tree are either unusually abundant the present season (the spring of 1891) or our fruit-growers are more carefully watching for insect depredations, and more eager for the knowledge of means of checking them than they have been in former years. Such action is wise, for just at this time orchards are exposed to attack of several insect pests, which, if not promptly checked, can not as well be destroyed later, and must necessarily prove of serious injury to the coming crop.

Mr. Dwight Stone, of Lansing, Oswego county, N. Y., has written me under date of April 27th, as follows:

Inclosed I mail you two insects; the little green one is easy to find, but the other is more difficult to detect. It is a worm in a sheath, which when fastened to the leaf, stands out at an angle of 45°, and looks, to the naked eye, something like a lettuce seed. When detached from the leaf, it comes (partly) out from the sheath and crawls like a worm. If touched it quickly draws back into its sheath. There are millions of the first named insects, and but few of the last in my orchard. Please give me their names and the probability of the latter to increase and do damage.

The green insects, of which there were many creeping over the opening buds, are the common apple-tree aphis. *Aphis mali* Fabr. They are still quite small, but have already undergone one molting since hatching from the eggs, as numbers of their cast shriveled skins are fastened to the buds. Wherever abundant, the injury that this insect causes in extracting the sap from the buds is so great that its increase should be promptly arrested by spraying with a strong soap solution, tobacco water, or the kerosene emulsion—the last, the most reliable.

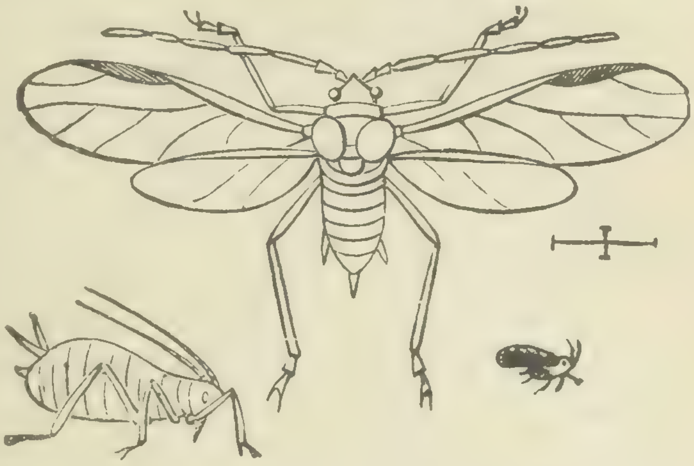

Fig. 52.—Apple-tree aphis, Aphis mali; winged and wingless forms.

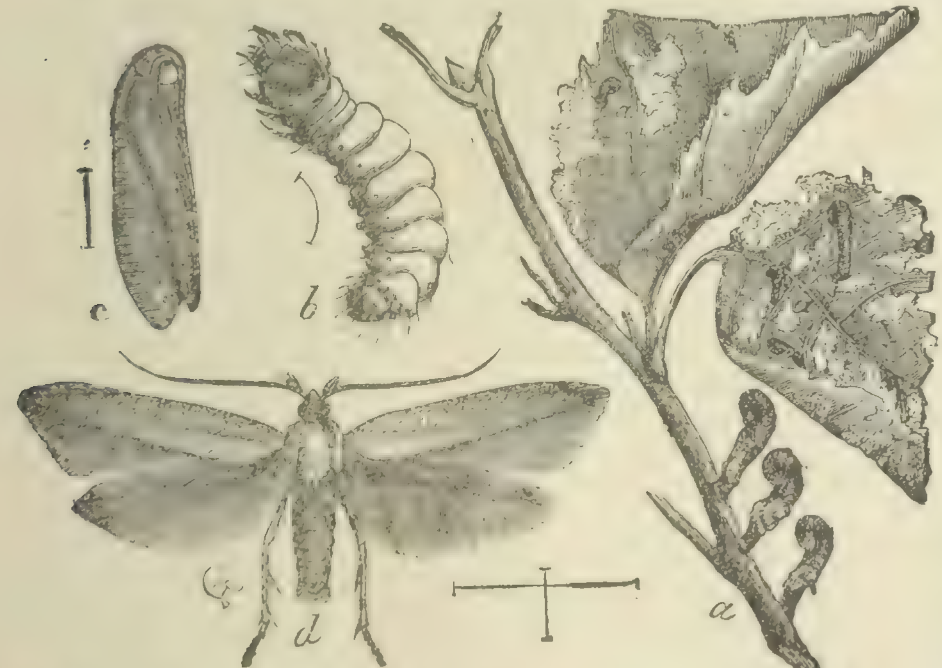

Fig 53.—The apple-tree case-bearer. Coleophora malivorella.—*a, a, a*, the cases containing the larvæ, shown in natural size; *b*, larva, enlarged; *c*, pupa, enlarged; *d*, the moth enlarged. (From Riley.)

The other insect, inclosed in a "sheath," is the apple-tree case-bearer, *Coleophora malivorella* Riley. It is apparently rare in the State of New York, as it is but the second time that it has come to my notice, the first having been noticed in the *Country Gentleman* for July 6th, 1882 (vol. xlvii, p. 533), as occurring in South Byron, Genesee county, N. Y. Its eggs were laid last July—the caterpillars hatching therefrom in September, and at once inclosing themselves in a brown, parchment-like cylindrical case, leaving an opening for the head and anterior segments to protrude, so as to admit of locomotion and feeding. The insect hibernated within this case, fastened closely to the twig. A few days ago, on awakening from its winter sleep, it sought the unfolding buds, and commenced to feed thereon. The case, which is slightly curved at its anterior end, is at this time, about one-twelfth of an inch in length. The larvæ will continue, unless destroyed, to feed upon the foliage until about the middle of June, when they complete their growth, transform to the pupa state within the pistol-shaped cases, which will then measure one-fourth of an inch in length, and give out the moth during the month of July.*

The proper treatment for this insect is arsenical spraying at the time of the opening of the buds, and at intervals thereafter, if required. It has been noticed at length in my *First Report on the Insects of New York.* The figure illustrating the insect is herewith given.

A third insect was found associated with the above, viz., the caterpillar of the eye-spotted bud-moth. *Tmetocera ocellana* (Schiff). This destructive caterpillar, which in its early stage eats out the buds of the apple tree and completely destroys them, is causing serious injury, and is apparently annually increasing in the orchards of our State. It may be killed by thorough spraying with Paris green, at the same time as for the case-bearer.

Mr. Malcom Little, of Malcom, Seneca county, has sent the following communication, dated April 27th :

> I inclose with this a box containing apple buds with at least two kinds of enemies. One is the aphis and the other a worm entirely new to me. There are empty cocoons on some of the twigs. The worm cuts the bud off in some instances. Will spraying with kerosene emulsion kill the worm ?

The buds submitted showed the presence of three insects. The apple-tree aphis was quite abundant. The little brown, black-headed caterpillar of the eye-spotted bud-moth was eating into several of the buds. The short bits of twigs bearing the blossom buds were, in some instances, whitened with the little ribbed, ellipsoidal, white cocoons of the apple-leaf Bucculatrix, *Bucculatrix pomifoliella* Clemens. Most of the cocoons were old ones of last year which had given out the moth and were more or less broken, but a number of them contained the living pupa, as was found by crushing them beneath the finger, which would in a few days have disclosed the winged insect in the orchard for deposit of the eggs of another brood.

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* The larvæ ceased feeding in June and fastened themselves to the sides of the box, but did not give out the imago. On examination, the cases were found to contain the dead and shriveled lavæ.

Both the bud-moth caterpillar and the pupæ of the apple-leaf Bucculatrix could be destroyed by the arsenical spraying repeated as often as found necessary. It would have been more efficient could the spraying have been done two weeks earlier, or at about the time of the first perceptible swelling of the buds. Possibly at this time (April 29th) some of the Bucculatrix moths have emerged, and have commenced depositing their eggs.

A third note of inquiry, from Mr. Frank Mothrop of Lincoln, Wayne county, dated April 26th, is as follows:

> Since receiving your reply to my letter concerning spraying our orchard, I have found three different insects that I would like much to know about, and I accordingly send them to you in this mail. The first is a small gray miller, which appears in numbers about my apple trees, especially in warm, sunshiny days. The second is a small green louse, of which there seem to be from one to four on every bud. Are they hurtful to the fruit, and what will have to be done to kill them? The third is a worm of about one-eighth of an inch in length, with a black head and brownish body, which seems to be eating into the bud. I do not find many of this kind, but I fear that more will hatch out.
>
> These insects are giving us a good deal of anxiety, and we would like to know if it would be better to spray for them now or wait until after the blossoming. Please answer as soon as possible.

Reply to the above was made, that although the little gray moths sent had lost nearly all of their scales in catching and handling them there was hardly a doubt that they were the eye-spotted bud-moth (named in the preceding notices), particularly as some of its larvæ, but recently hatched, were found feeding in the buds. This is the third insect mentioned in the above note. The oviposition of the bud-moth extends over quite a period of time, so that the conjecture that others than those now seen will make their appearance, will probably be confirmed. The observed flight of the moth in the daytime is of interest, as it has not been recorded. No time should be lost before spraying with Paris green for the caterpillar. [See NOTE A, appended.]

The second insect, mentioned as "a small green louse," indicates a new and dangerous attack in the orchards of our State, viz., that of the pear-tree Psylla, *Psylla pyricola* Foerst. This insect was referred to in a communication made by me to the *Country Gentleman* for April 16th, entitled, "Honey-Dew on Pear Twigs." A few days since some blossom buds were brought to me from an apple orchard of Mr. George T. Powell, of Ghent, N. Y., which showed a formidable attack by this pest. The living insects were seen when the buds were picked, but when they came to me only their dead and shriveled remains could be found, but the stems bearing the buds were thickly and conspicuously coated with a "honey-dew," which had been excreted by the Psyllids. The presence of this honey-dew always serves, at this season and onward, to disclose the attack of the (at this time) small and almost hidden larvæ.

This species of Psylla usually infests the pear. Its occurrence on the apple has been noted by writers, but the above was the first time that it had come under my observation. Its occurrence in the apple orchard at Lincoln is the second instance.

It has not been studied in this country, and most of our knowledge of it is obtained from European authors. From its formidable attack in pear orchards in the Hudson river valley, it now claims the attention of our economic entomologists. [See Note B.]

So far as we know its natural history, it may be best fought by spraying with a kerosene emulsion early in the spring, before the hatching of the eggs, or just after the insect has emerged. Later, it will probably be found to be enveloped in its copious excretion of honey-dew that will make it difficult to reach by external applications. In classification and general appearance, Psylla is near the plant-lice, and, like them, takes its food by suction. (*Country Gentleman*, of May 7, 1891.)

Note A.—In the light of subsequent studies, it appears that my identification with some doubt, of the moths received from Mr. Mothrop, can not be sustained. Prof. M. V. Slingerland, of Cornell University, has fully worked out the life-history of the eye-spotted bud-moth, and shown that the winged insect comes abroad during the month of June and early July, and that there is but a single brood—not two, as I indicated in a brief notice of the insect in my Seventh Report, page 307. See Bulletin 50, March 1893, of the Cornell University Agricultural Experiment Station, for Professor Slingerland's elaborate study of the insect.

Note B.—The pear-tree Psylla, in consideration of its excessive multiplication and severe injuries in 1891, has, since the above was written, been given the study that its economic importance demanded. In Bulletin 44, October, 1892, of the Cornell Experiment Station, Professor Slingerland has given us in careful detail the life-history of this interesting insect, description and illustrations of all its stages, and the satisfactory results of experiments made for its control. My own observations upon it are in the MS. of my Ninth Report, awaiting publication.

SOME INJURIOUS INSECTS OF 1890.

The following notes from a paper read by Hon. Daniel K. Young, of Oyster Bay, Queens Co., N. Y., before the Queens County Farmers' Club, were submitted to me for any comments that it might be thought desirable to make upon them.

1. In the summer of 1890, there was noticed in growing wheat a partial blight. The leaves lost their normal green, turned brown, and withered. Rye was similarly effected, but less seriously; there was also noticed in rye scant filled heads and much shriveled grain. This was attributed to insect depredation. The causes were not investigated nor the extent of damage noted.

2. Oats was ruinously blighted in an early stage of growth, similar to, but more seriously than wheat. There is also an insect enemy of many years standing, which has rendered the kernel almost valueless. No satisfactory exposition of this has been made public.

3. The marketable value of potatoes is seriously impaired by what is popularly known as "Scab." This is undoubtedly caused by insect perforation, but when or at what stage of growth of the tuber is not positively known.

4. The elm-leaf beetle, or rather the larva, has disfigured and seriously injured elm trees several seasons past. The frequent drenching rains in August and later in the season of 1889, destroyed quantities of the pests while in the pupa state, before transformation to the perfect beetle was completed. This gave false hope of its destruction. The few that appeared in the spring of 1890 increased without molestation, and the approaching season will probably show a material increase.

5. In view of the fact that the Colorado and the Asparagus beetles have been kept in subjection by remedies which timely investigation proved efficient, the Committee suggest that the managers institute inquiries into these matters, and if necessary, at the proper season invite the State Entomologist to personally investigate, and report upon what they are, their different stages and habits, so that the lay mind may comprehend sufficiently to institute inquiry, observation, and remedies.

A few remarks may be made upon the above:

1. Examination of wheat and rye from several localities, affected in the manner above described, showed the discolored portions to contain multitudes of a minute nematode worm — one of the *Anguillulidæ*, which were undoubtedly the cause of the discoloration and the partial blight. The particular species was not determined.

During the past two or three years, nematode attacks have been found to be very common in a large number of plants. Careful study has been given to them both in this country and in Europe. Dr. J. Ritzema Bos, of Wageningen, Netherlands, has published the results of his elaborate studies of *Tylenchus devastatrix* — one of the most common species. Miss E. A. Ormerod has detected them as causing much of the so-called "clover sickness;" and in this country, the life-history of *Tylenchus radicola* which infests a large number of our agricultural products, has been worked out by Professor Atkinson, then of the Georgia Agricultural Experiment Station.

The Department of Agriculture, at Washington, has also published an extended report upon the Nematodes prepared by Dr. J. C. Neal, an agent of the Department.

2. The blight in the oats is probably that which has been noticed by Messrs. Galloway and Southworth in the *Journal of Mycology*, vol. vi, 1890, page 72. It was prevalent that year during the months of May and June, in several of the United States — in some of them injuring the crop from thirty-five to seventy-five per cent. Nothing in the way of a fungus or animal parasite as the cause of the trouble could be found, but bacteria were present in every specimen examined.

The insect causing the shriveling of the oats, was the well-known grain-aphis, *Siphonophora avenæ* (Fabr.). It was not destructive generally throughout the State during the year, but in two or three localities it was reported as having injured the wheat crop to an extent of from twenty-five to fifty per cent.

3. For the "potato-scab," of which frequent complaints are being made, no effectual preventive has as yet been found. Much attention has been given to the disease, and considerable progress has been made in its investigation. It appears that there are several kinds of scab, resulting from different causes. It has been variously referred to injuries from insects, as the wire-worm and white-grubs; to injuries from millipedes (thousand-legged worms), earth-worms and mites; to excessive moisture in the soil producing an abnormal growth of the corky tissue; to lime or oxide of iron in the soil; to fertilization by stable manure; to the action of bacteria; and to fungus attack.

That one of the "scabs" is caused by, or at least is always associated with, bacteria, seems to have been demonstrated by Mr. L. H. Bolley.* Another form has been found by Dr. Roland Thaxter, of the Connecticut Agricultural Experiment Station, to be due to a fungus attack, the particular species of which has not yet been determined.† This has been named as the "deep scab," while another form, known as "surface scab," often associated with it, may prove to be only a modification of the former.

4. The beneficial effect of heavy rains in destroying the elm-leaf beetle, *Galerucella xanthomelæna* (Schrank), has not, we believe, been previously reported. That such should be one of the results of heavy

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* *Agricultural Science*, iv, 1890, p. 243.

† *Ann. Rept. Conn. Agr. Exp. St.* for 1890, pp. 81–95, figs. 1, 2.

rain-fall seems quite reasonable, knowing its service in arresting the multiplication of plant-lice in early spring, as well as of other species of insects. This suggests the feasibility of killing the larvæ when descending the tree-trunks for pupation, by simply spraying with cold water, throwing it upon them with force from a nozzle having rather large holes. It would, of course, be more effective, with very little additional trouble, if some simple insecticide, such as tobacco or soap, were added to the water.

5. The State Entomologist will always be glad to investigate any new form of insect attack that may be brought to his notice, or to propose such remedies or preventives as have been found serviceable against such pests as may have been already successfully studied.

The above, essentially, was communicated to Mr. Jacob Hicks, of Old Westbury, N. Y., with thanks for his kind submittal to me of Mr. Young's paper, containing, as it does, observations intelligently made and ably presented.

APPENDIX.

(A)

ENTOMOLOGICAL ADDRESSES.

SOME INJURIOUS INSECTS OF MASSACHUSETTS.

[Read before the Massachusetts State Board of Agriculture at its Country Meeting at Framingham, December 3d, 1885.]

Gentlemen. — Before proceeding to discharge the pleasant duty that I have undertaken in compliance with the kind request that you, through your secretary, have done me the honor of making,— that I would give you some practical remarks on insects with which you have to contend in your farming operations,— will you please allow me a few preliminary words.

Always glad, as I am, of an opportunity to commend the importance of the study of economic entomology, and to give some evidence of what it has accomplished, it is with more than ordinary pleasure that I am permitted to address the Massachusetts State Board of Agriculture. Not because I have been assured that I would find an appreciative audience, but that I can avail myself of the occasion to make public acknowledgment of the debt of gratitude that American agriculture owes to you, to those who have preceded you, and to your State, for what you have done in the promotion of economic entomology.

Here in Massachusetts the science had its birth, and to the fostering care that it has continued to receive we are largely indebted for the proud position that it at present holds.

Nearly a century ago — in the year 1793 — a prize was offered by the Massachusetts Society for Promoting Agriculture, for the best essay to be presented to it upon the "canker-worm,"— an insect which, according to a statement made in the "New England Farmer" in 1790, had at that time been a destructive pest in many portions of New England for fifty years. The prize was awarded by the society to William Dandridge Peck, for his paper entitled the "Natural History of the Canker-Worm," published in the year 1795. The paper was worthy of being a pioneer in a new line of investigation.

Mr. Peck's studies upon the canker-worm were made at Kittery, Maine, but he was subsequently called to Harvard College. In 1817, another paper, "On the Insects which Destroy the young Branches of the Pear-Tree, and the leading Shoot of the Weymouth-Pine, by W. D. Peck, Esq., Professor of Natural History and Botany, at Harvard University" (I cite from the paper in my library), was published in the "Massachusetts Agricultural Journal" (January, 1817, vol. iv, pp. 205-211), by the society before mentioned.

The lectures of Professor Peck were attended by Thaddeus William Harris, of Dorchester, Mass., during the years 1813-15. Of his instructor, Dr. Harris, in his later years, wrote: "It was this early and much esteemed friend who first developed my taste for entomology, and stimulated me to cultivate it."

I need not dwell at length upon the entomological labors of Dr. Harris, for they are familiar to you all. To him, perhaps more than to any other man, do we owe the widespread interest felt in the study of the insect world. His collection of insects was commenced in or about the year 1820, at the time when he entered upon the practice of his profession at Milton; and during his residence here and at Dorchester most of his out-door researches were made. His studies were untiringly continued for the remainder of his life, during the long period of twenty-five years that he held the librarianship at Harvard University, subsequent to the year 1831.

At the commencement of his librarianship he was honored with the preparation of a Catalogue of the Insects of Massachusetts, which was appended to the geological report of the State by Professor Hitchcock. Ten years later, in 1841, was published his "Report on Insects Injurious to Vegetation,"—one of the scientific reports which were prepared by the Commissioners on the Zoological and Botanical Survey of Massachusetts, agreeably to an order of the General Court, and at the expense of the State. It has the honor of being the first government publication on insects issued in the United States. Subsequent editions have appeared of this report, with additions in 1852, and again in 1862,— the latter with illustrations. Of this work it may justly be said,— The State has honored itself in its publication. Although so many years, marked with wonderful progress, have elapsed since its preparation, it is still the first volume that I recommend to those who desire to learn of insects and their habits; for it stands to-day as fresh, as interesting, as valuable as when first issued from the press — unsurpassed, we believe, by any similar report in any other department of natural history ever published.

Your own Board has done much to encourage entomological studies. I have in my possession a paper, entitled "Economic Entomology, by Francis G. Sanborn, Entomologist to the Massachusetts Board of Agriculture," without date of issue, but probably published about the year 1860.

"An Essay on "Some of the Insects of Massachusetts which are Beneficial to Vegetation," by the same author, as entomologist to the Board, and forming a portion of the report of your Secretary for the year 1863, is a valuable contribution, treating of insects in their several orders, and illustrating them in sixty figures.

In the years 1871, 1872, and 1873, three valuable reports were made to your Board by Dr. A. S. Packard, Jr., upon the "Injurious and Beneficial Insects of the State of Massachusetts." So able were these reports and of so great practical importance to agricultural interests, that it is much to be regretted that provision could not have been made for a continuation of the series.

There are, doubtless, among the publications of your Board, other contributions to the science, to which reference deserves to be made, of which I have no present knowledge.

In this connection it is proper that I should refer to a collection in economic entomology that within the last few years has been quietly brought together and built up at the Museum of Comparative Zoölogy, at Cambridge, by the distinguished professor of entomology, Dr. H. A. Hagen, under the fostering care of Alexander Agassiz. It has for its object a better opportunity of acquaintance with the insect world than can be afforded by the study alone of books. To this end there have been arranged, in convenient cases, in connection with each insect shown, its several stages of the egg, the larva at different periods of its life, and the pupa; its architecture, in its cocoons, nests, burrows, etc.; its various food-plants, showing methods of attack and injury; diseased conditions resulting from fungus and other attacks, or from causes producing monstrosities and deformities; the several parasites that prey upon it,— in short whatever may serve to illustrate the entire natural history of the insect. So rich has this collection already become, in its 5,000 species more or less fully illustrated, that I give it but the praise that it deserves when I say that it has not its equal in any other collection of the kind in the world.

Nor should I omit passing reference to the good that has resulted from the Entomological Department of the Cambridge Museum, in that the study of its collections and the instruction of its professor have largely influenced the habits of thought and paths of labor of several students who are now successful teachers of entomology in our colleges and universities.

I can not now refer to the many notable contributions made by the members of your scientific bodies and others to general entomology, in the extensive collections gathered, in the new forms described, the life-histories given, the anatomical and historical investigations pursued, and the classifactory work done. Not alone are these lines of study, one and all, of great importance in themselves, and their pursuit ennobling — for the humblest insect that lives is richly worthy of the attention of the highest intellect,— but further, each one of you, each member of community, has direct interest in such labor, indispensable as it is to a proper knowledge of the insect world, with which we are brought into such intimate and dependent relations, in our cultivation of the soil, within our homes, and everywhere.

Without occupying more of the time allotted to me in referring to several other topics of which I would love to speak to you, I will pass on to meet the purpose of my invitation hither.

But how could I discharge the duty of even a brief discussion of the numerous insect pests which with each returning year force themselves upon you, and compel battle with them if you would not permit them to wrest from you often the entire results of a season's toil ? Fortunately, your Secretary has kindly extricated me from this dilemma in sugggesting to me a few insects upon which a desire has been expressed by several of your number, for information that will prove serviceable in arresting widespread and serious depredations.

I will ask your attention, first, to a class of insects which — although occurring abundantly in almost every portion of our country, everywhere occasioning serious losses, and although volumes have been written of them — are yet very imperfectly known by those who are suffering from their depredations.

CUT WORMS.

Before we can contend successfully with our insect foes, it is necessary to know who and what they are.. There is no universal panacea for insect injuries. The natural history and habits of each species requires separate study, and not until we have become acquainted with all the conditions of their existence are we prepared to make recommendation of the best means to be employed against them. So varied are these conditions, even among the members, often, of the same genus, that a remedy that will be efficient with one will be powerless against another. The bearing of these remarks will be evident when we state that, not unfrequently, a reported "cut-worm" attack proves, upon examination, to be that of quite a different insect, — perhaps that of the "white-grub" or some allied coleopterous larva,— of one of the many species of "wire-worms," the larvæ of our "snapping beetles," — or it may be of a "thousand-legged worm," which does not even belong to the class of insects. The nature of the injury committed by these several forms is much the same; roots are eaten, or stalks and blades are cut off, and it is *believed* to be caused by a cut-worm. Surely, guessing at the cause of an injury is incompatible with scientific treatment for its arrest. Whenever, therefore, any unknown form of insect attack presents itself to the farmer, the gardener, the horticulturist, the florist, — let him first learn the particular depredator he has to deal with, and then seek the best remedy, either from books authoritative upon the subject, or from some one prepared and competent to give advice.

If the study of our common insects had that place in our public schools and other institutions of learning that its practical importance ,entitles it to, the labor of the economic entomologist of the present day would be lightened, and much of what may be regarded as preliminary instruction would be spared him. It should not be necessary in a paper like the present to tell what a "cut-worm" is, yet if I give its principal features, and those of the winged form into which it develops, I think that I shall be imparting serviceable and acceptable information to some.

What are cut-worms? — Cut-worms are the caterpillars of an extensive family of moths known by the name of *Noctuidæ*, from their coming abroad for flight chiefly during the night; the moths (nocturnal) united with the butterflies (diurnal) forming the order of LEPIDOPTERA, so named from the myriads of small scales which, in symmetrical arrangement like the shingles or tiles of a roof, cover and color both the upper and lower surfaces of the membranous and veined transparent wings.

There are many distinct species of cut-worms, but we can not give even their approximate number. Most of them belong to three genera of the *Noctuidæ;* viz., *Agrotis*, *Mamestra*, and *Hadena*, of which about 400 United States species have been described. Some of these are known not to possess true cut-worm habits, but of much the larger number the caterpillar stage remains unknown.

The following are the principal cut-worm features possessed in common by nearly all the species, and which should suffice for their recognition. When full-grown, they measure from an inch and a quarter to nearly two inches in length. They have sixteen feet, of which the three anterior pairs (true legs) are pointed, and the five remaining pairs (prolegs), stout, blunt, and armed with minute hooks for clasping. In form they are stout, tapering slightly toward the extremities. In appearance they are usually dull-colored, greasy-looking, dingy-brown, gray or greenish, with some light and dark longitudinal lines, and sometimes with oblique dashes. They have a large, shining, red or reddish-brown head. The first ring, or collar, bears a darker-colored, shining, horny plate, as does also the last one, known as the anal plate. The body is never hairy, but the several rings have upon each six or eight small, blackish dots or humps, from each of which a short hair is given out.

Their habits.—It is the habit of the cut-worm to pass the day in rest, hidden in a hole made in the ground beside its food-plant or among its roots, or in concealment beneath stones, sticks, rails, or other convenient shelter. The night is the season of their activity, when they seek their food. Some of them feed only beneath the surface of the ground upon the roots of plants; others thrust their body in part from their burrow and cut off the blade, which they take with them into the ground to feed upon at their leisure; while others come abroad and make vigorous attack upon the young annual plants of the garden or the field, feeding upon their tender tips or severing the stalks. If search be made for them at night-time with a lantern, they may often be found by hundreds busily engaged in their destructive work. At the approach of day they again seek their hiding-places, often in the hole made near the plant. When taken from the ground or disturbed in their shelter, they usually curl themselves up in a ring.

A few of the moths may be seen by day, feeding upon the nectar of flowers, as of the golden rod (*Solidago*) and some others; but nearly all of them pass the day in sleep in various hiding-places, such as under the bark of trees, in piles of wood or stone, in crevices of walls, behind closed window-blinds, or in any convenient, dark, secluded retreat. They are generally of obscure colors, in some shade of brown. When in repose, their wings are folded almost parallel to the surface upon which they rest, and in line with their body, giving them an elongated form. The wings are thick, smooth, often shining, and marked with characteristic lines and spots which are usually not very conspicuous.

Natural history.—The eggs that produce the cut-worms are usually deposited by the moth upon some low plant convenient to the food that is destined to nourish them. Sometimes, however, as in *Agrotis saucia*, they are placed in long, narrow patches upon small twigs of apple, peach, and other fruit trees, quite removed from their natural larval food. The general time of their deposit is in the latter part of summer. Hatching in a short time, the larvæ enter the ground and commence to feed upon the young roots of various plants. With the cold of winter, they cease feeding, and bury deeper in the ground, where they shape for themselves an oval cavity in which to pass the winter in a torpid state. In this condition, if undisturbed, freezing fails to harm them. In the early spring they resume their activity, make their way toward the surface, and commence their feeding upon the starting vegetation.

Within a few weeks they become full grown, when they again bury in the ground, where they mold a cell, or earthen cocoon, in which to undergo their transformation to the pupal state. Two or three weeks are required for this stage, when the moth issues from the rent pupal case, and makes its appearance above ground. The wings, at first small and contracted, are soon expanded, and the insect has reached its perfect stage. The sexes meet, eggs are deposited for another brood, a little food is partaken of, consisting of the nectar of flowers or other sweets, and within two or three weeks, ordinarily, if not sooner terminated by their many enemies, the life-cycle is completed. In some instances a second brood follows during the summer and autumn, but with most of the species the life-history is as above given. Occasionally the hibernation is in the pupal stage.

Food-plants.— Many of our injurious insects confine their depredations to a single food-plant, or to the members of the same genus, or to closely allied plants. The cut-worm, unfortunately, is more indiscriminate in its taste; and although certain species show a decided preference for some particular food-plant, yet, if this is not convenient, other substitutes are readily accepted. When we add to this the varied tastes of a large number of species it ceases to be a surprise that so many of the products of our fields and gardens suffer from their aggression.

Their injury to *grass* is far more serious than is supposed. It is believed that the first half of the active life of many of the species is passed in feeding upon the roots of grasses, and that they only assume the true cut-worm habits when approaching maturity demands stronger and more abundant food. Usually their presence in grass lands is unnoticed, or, if an impaired growth is observed, it is ascribed to other causes. But at times, for reasons unknown, they multiply to such an extent that we may no longer be blind to their ravages; as in the visitation of the bronze-colored cut-worm, *Nephelodes violans* Guenée, in 1881, in the northern counties of the State of New York, when the pastures and meadows suffered largely from their attack; and of the black-lined cut-worm, *Agrotis fennica* (Tausch.), in Michigan, last year, when, as represented to me by Professor Cook, of the State Agricultural College, there were meadows through which one could not walk without crushing from a dozen to a hundred at each step.

Corn is known to be a favorite food-plant of many species, of which we recognize twelve by name — the two more common ones being *Agrotis clandestina* and *Hadena devastatrix.* Experience has taught every farmer that a cornfield upon a newly turned sod is a luxurious home for the cut-worm, where they particularly abound. It is stated that sixty have been taken from a single hill of corn.

Wheat and *barley* occasionally suffer from their attack, but we are thus far favored by not having had introduced among us, with the scores of imported pests brought by commerce to our shores, the wheat dart-moth, *Agrotis tritici*, or the common dart-moth, *Agrotis segetum*, which cause such enormous losses in the European wheat fields. None of our species are nearly so destructive as these to this staple crop.

Entire settings of young *cabbage plants* are often destroyed by them. In one plot of 600 plants, only thirty escaped. The owner killed about 200 of the worms on the first day of their appearance, and 500 or more on the following day, after which the ground was reset with late cabbages. Of the species known to prey upon cabbage, are *Agrotis clandestina*, *Agrotis saucia*, *Agrotis annexa*, *Mamestra subjuncta*, *Mamestra trifolii*, and *Hadena devastatrix*.

Turnips are liable to attack by being eaten into around the neck of the plant until it is detached, or by its separate leaves being cut off and drawn into holes near the plant.

To *onions* they are at times so destructive as to ruin entire crops. In one field of four acres in Chautauqua county, N. Y., upon which onions had been grown for sixty years, the worms were dug out and killed in almost incredible numbers — to the amount of "bushels," in some years, it is stated.

A remarkable attack was made upon onions, in Goshen, Orange county, N. Y., the present year, where several hundreds of acres of drained swamp-land are devoted to their culture. The worms appeared in myriads, in June, as soon as the onions had started,— first eating them from their tips downward, but later developing the true cut-worm habit in severing the stalks. The species was believed to be *Agrotis malefida*, a southern form, not hitherto noticed injuriously so far north. [On rearing the perfect insect it proved to be *Agrotis messoria* Harris.]

The tender stems of young *beans* furnish tempting food, and every one who has grown them knows the frequency with which they are found, in the morning, with severed stems, showing the operation of the cut-worm.

In portions of Canada, *clover* suffered severely from a formidable attack of a caterpillar which was thought, at first, to be the army-worm, but which, upon rearing the moth, proved to be one of the cut-worms, *Agrotis fennica*.

Tobacco plants, are often cut off in the month of June. In West Meriden, Conn., from one row of 180 plants, 214 of the worms were taken and killed.

They frequently attack and destroy *flowering plants* in our gardens, as hyacinths, pansies, carnations, nasturtiums, phlox, asters, balsams, and many others.

Among other garden and field crops, to which they are destructive, may be mentioned pease, beets, potatoes, tomatoes, pumpkins, melons, and squashes.

Natural enemies.— The large size of the cut-worms, their hairless bodies, and no provision for protection except their concealment by day, render them attractive and an easy prey to their many enemies who persistently seek them for food, and by the large numbers that they devour greatly mitigate the injuries that their unchecked increase would otherwise cause. Several of our common birds render effective service in this direction. Foremost among these is the robin, of which it has been said: "Its eminently terrestrial habits, its fondness for larvæ of various kinds, and its ability to obtain those that are hidden beneath the turf, give it a usefulness in destroying cut-worms which no other bird possesses in the same degree, and for this feature in its economy alone, its greater abundance should be encouraged. Early in the morning, and toward the close of the evening, the robin may often be seen searching for cut-worms in lawns, pastures, and meadows, and when thus engaged it hops about, gazing apparently more at distant objects than searching for something near at hand; then, suddenly, it commences tearing up the old grass and turf with its bill, and, in another instant, it stands triumphant with its wriggling prize in its bill, for it rarely digs in vain. I have seen a robin capture, in this manner, five cut-worms in less than ten minutes, and five other birds within view were doing the same work."

Other birds that are known to prey upon cut-worms are the cat-bird (*Mimus Carolinenis* L.), the red-winged blackbird (*Agelæeus Phœniceus* L.), and the purple grackle (*Quiscalus purpureus*).

Poultry, and especially chickens, are efficient destroyers of them in gardens in the spring, when they scan closely the upturned ground, and are quick to detect and devour them.

Among the members of their own class that feed upon them, is the larva of a ground-beetle, known as *Calosoma calidum* (Fabr.). It is so destructive to them, and attacks them with so much energy, even if the worm be twice its size, that it has been designated as the "cut-worm lion."

The larva of another beetle, *Harpalus caliginosus* (Fabr.), is also its persistent enemy; and from its ferocity in seizing its prey, and its strange, irregular form, it has been called the "cut-worm's dragon." Dr. Fitch has written of it: "When not glutted with food, it is running about incessantly in search of these worms, and slays them without mercy; with its powerful jaws seizing them commonly by the throat, and, regardless of their violent writhings and contortions, sucking out the contents of their skins." Others of the same family of beetles, the *Carabidæ*, also feed largely upon them.

One of the HEMIPTERA which preys upon quite a number of other species of insects, and which from its belligerent propensities has received for its common name that of the "spined soldier-bug," and is known in science as *Podisus spinosus* (Dallas), will fearlessly attack a young cut-worm much exceeding it in size, and piercing it with its formidable beak, extract its juices from it, leaving only its shrivelled skin.

The toad deserves introduction, shelter and protection in our gardens, from its coming abroad at night during the period of activity of the cut-worms, and contributing largely to the diminution of their numbers.

Parasites. — The quiet and concealment in which these nocturnal marauders of our gardens and fields pass their time during the hours when most of the parasitic insects are upon the wing, in ceaseless search for their victims, into which they can thrust their ovipositor and insert the fatal egg, give them a large degree of immunity from parasitic attack. Yet as even the "white-grub," which never appears above ground, is sought out in its subterranean retreat by its parasite, *Tiphia inornata*, so even these are far from enjoying immunity. The bronze-colored cut-worm before referred to, in my attempts to rear it, has proved to be quite liable to be parasitized by one or more species of a Tachina fly. A species of Microgaster, *Apanteles militaris* (Walsh) and an *Ophion* have also been obtained from it. Other parasites reared from other larvæ are *Paniscus geminatus* (Say), a large yellowish-brown ichneumon fly; *Nemoræa leucaniæ* (Kirkp.); *Masicora archippivora* (Riley); and *Scopolia sequax* Williston — three species of Tachina flies.

Preventives and remedies. — The measures recommended for preventing or arresting cut-worm ravages have been exceedingly numerous, and perhaps each one might claim a degree of value under certain conditions, but at the present only those from which the best results have been obtained will be referred to.

When grass is infested, as in lawns, it is difficult to control the attack. Perhaps gas lime where it can be obtained, applied at the commencement of winter, would penetrate to a sufficient depth to kill the larvæ. Usually it will be found necessary to sacrifice the sod. It is claimed that where land is not allowed to lie in sod for over two years at a time, the worms will not accumulate in it. Removing their food is an effective method. This may be done by turning over the grass before it has made much growth in the spring, and dragging, to bring up the roots to the surface for drying. A week later, another thorough dragging will destroy all green vegetation. Late ploughing, in the autumn, is said to be an effectual remedy, if deferred until the cut-worms have become torpid, and the ploughing sufficiently deep to crush the cells that they have shaped for their winter's sleep.

Two preventives of attack to cornfields have been given, which, from the testimony borne to their efficacy, may be accepted as reliable. The first is the simple and easy application of *salt*, as follows: Immediately after the corn is planted, sprinkle on the hill, over the covered grains, about one tablespoonful of common salt to each hill. The explanation given for the protection of the plants is, that as the salt dissolves and is carried to the roots and taken up into the circulation, the young corn becomes unpalatable to the worms, and they will not eat it, while the direct application of salt to them is harmless, even if they be buried in it.

The second method, which has been tested by the gentleman recommending it and by others for twelve years, and always with success, even upon new ground and clover land, is soaking the corn, before planting, in *copperas water*. Tests had been made by planting portions of a field without the preparation, and these portions in several instances required replanting two or three times. The manner of preparing the corn is as follows:

Put the seed corn in a tight tub or barrel, and pour in enough water to keep it well covered after it swells. For each bushel of corn add a pound or a pound and a half of copperas, dissolved in warm water. Stir well, and allow the corn to remain in the copperas water twenty-four or thirty hours. Stir several times while soaking. Then take it out and sprinkle a small quantity of land-plaster over it — enough to prevent the grain from sticking together,— and plant. When prepared as directed, if a change should occur in the weather to prevent planting, the corn may be spread out upon a floor and allowed to remain until good planting weather.

As a test of the efficacy of the above preventive, a forty-four-acre field of corn was planted, — first, ten acres without the copperas preparation,— next to it, nearly ten acres with the prepared seed, and the remainder with unprepared,— otherwise, all treated alike. As the result, *not a hill was cut or a worm was found where the copperas had been used;* while the entire field elsewhere was cut, from two to three hills out of five, with sometimes fifteen cut-worms in a hill.

There is a prejudice against the *digging-out-by-hand* method, as requiring too much valuable time and labor, and therefore not available where large fields are to be protected; yet it is one of the best means to be employed against this pest, unless the poisoning method recently recommended, and next to be referred to, shall be found to give easier protection.

Many of our preventives merely drive away the hungry creatures to attack and destroy other and perhaps more valuable crops; but with a cut-worm dug out from its hiding-place beside a wilted plant and killed, there is the satisfaction, not only that its possibility for further harm is ended, but that it will not develop into a moth the following season, which might deposit 200 eggs, each of which would produce a cut-worm.

Mr. Armstrong, secretary of the Elmira Farmers' Club, has stated: "There is really but one way to save the crop after the plants are once attacked by cut-worms; that is, to dig the worms out and kill them. It is not a difficult task, nor is it very costly. I presume that a fourth part of the loss sustained would be a full equivalent of all the labor it would cost. The worm does the mischief at night, and before morning burrows in the ground near the spot where its depredations have been committed. A practised eye will readily discern the entrance to the hiding-place into which the worm has passed and lies concealed. The way to bring the pest up is to thrust a pointed knife down near the hole, and lift out the earth to the depth of two or three inches, when the malefactor will lie exposed to view, and can be instantly destroyed. I have known large fields to be cleared by this process at a cost of labor so slight as to bear no comparison with the loss that would have otherwise resulted."

The practicability of this method, and an idea of the expense attending it, will appear from a statement made by a correspondent of the *Country Gentleman.* A six-acre field of corn, planted on sod turned over from a pasture before planting, showed a strong attack of cut-worms. Two men were employed to dig them out. Taking a row at a time, and digging down wherever a plant was cut, they went over the field in half a day, killing over fifteen hundred. A few days later they went over it again, not getting as many; and again, for a third time. Without this labor, it was thought that one-half of the crop would have been lost. The three days' work was worth four dollars, and at least 100 bushels of corn were saved by it.

The poisoning method referred to is the use of a *bait of leaves or clover*, of which the worms are fond, *poisoned with Paris green.* Professor Riley, in his last report as entomologist of the United States Department of Agriculture, has recommended clover sprinkled with Paris green water, and laid at intervals between the rows, in loosely tied masses or balls, which serves the double purpose of prolonging the freshness of the bait, and of affording a lure for shelter.

A modification of the method, employed by Dr. Oemler, of Savannah, Ga., was that of preparing cabbage or turnip leaves by dipping them in a well-stirred mixture of a tablespoonful of Paris green to a bucket of water, or sprinkling the side next the ground after first moistening, with a mixture of one part of Paris green to twenty of flour, and then placing the leaves at distances of from fifteen to twenty feet throughout the field to be protected. Two applications of this character, at intervals of three or four days, particularly in cloudy weather, were usually successful in ridding the field of the pest.

Other remedial and preventive measures deserving mention are: application of coal oil; paper frames from six to eight inches square; tin bands, ten inches long by two wide, lapped at the ends in a ring; paper wraps around the stalks at setting; and trapping in holes, for the protection of young cabbage and tomato plants; as also, thick planting and subsequent thinning; and starvation through the removal of all green food, for more general protection. Notice of these several methods may be found in a paper entitled, *Cut-Worms*, read by me before the New York State Agricultural Society, at its annual meeting, in January of the present year.

TOBACCO WORMS.

Representation has been made to me that serious and increasing losses are being sustained in portions of Massachusetts, from tobacco worms, accompanied with the request for means of prevention. I am not told what the worm is of which the complaint is made.

If it be the insect that is commonly known as the "tobacco worm," in New York and Connecticut, then it is the larva of a sphinx moth *Sphinx quinquemaculata*. The true tobacco worm is the larva of *Sphinx Carolina*, which is so very destructive to tobacco in the Southern States. The two species are very closely allied in appearance and habits, and in Pennsylvania often occur together.

The larva of our five-spotted Sphinx is well-known to all of our tobacco growers. It is a dark-green, smooth caterpillar, with seven oblique greenish-yellow stripes on each side, a long, curved horn upon its terminal end, and, when full-grown, is of about the size of the third finger of a man's hand. The moth is a large and handsome insect of a general ash-gray color, its stout body marked with a row of five orange-colored spots on each side. It comes abroad at twilight for the deposit of its eggs, and so marked is its resemblance to a humming-bird in size, rapidity of flight, and its hovering over flowers when taking its food, that the popular name of "humming-bird moths" has been given to that group of the *Sphingidæ* to which it belongs.

The eggs of the moth are deposited upon the tobacco plants during the months of June and July. The caterpillars feed upon the leaves of the plants in late July, August, and September, even up to the time of securing the crop. In an instance related to me,— in a curing-barn, near Albany, N. Y., shortly after the hanging up of the plants for curing, the floor beneath was found "nearly covered" with the caterpillars of *S. quinquemaculata.* As illustrating the abundance in which they at times occur, it may be mentioned that a market gardener collected from one acre and a quarter of tomato plants,— a favorite food-plant of the species,— four bushels of the caterpillars, in one day (*Report of the Entomological Society of Ontario for* 1880, page 27).

The only sure remedy for the attack of this insect is that which is known among tobacco growers as "worming." The plants must be searched for the worms two or three times a week, or as often as is found necessary, and the worms destroyed. The mornings and evenings and cloudy days are the most favorable for finding them.

Poisoning the moths to prevent the laying of the eggs is also resorted to. A gentleman gives this as his method: "In every tenth hill, on the outside of my field, I sow the seed of Jamestown-weed (*Datura stramonium*), instead of setting tobacco plants. As the Daturas grow up I pull out all but two to each hill, and when these are in bloom I go around every evening, and, after destroying all but two flowers, pour into these a few drops of common fly poison, mixed with sweetened water and whiskey. The moths sip the poison and die from it, and I find them scattered over the farm for the space of several hundred yards." Another writer gives these directions for the poisoning: "Provide a weak solution of cobalt and a little honey, place it in a bottle having a small quill through the cork, and late each evening go around the jimson weeds and put a few drops of the mixture into the blossoms. The poisoning must be done every day through the fly season, care being taken each evening to pull off the blossoms that were poisoned the day before, as, if left on, they seem to destroy the plants."

So far to the northward as Massachusetts, the Jamestown-weed might not flower in season for the early coming of the moths, unless the seed should be put in as early as possible.

Knowing the attractiveness of the petunia for our Sphinx moths, I would suggest that benefit might be derived from placing a large bed of these flowers in the neighborhood of tobacco fields, and employing children to catch with insect nets the moths that are attracted to the flowers at twilight, and killing those that bear the five orange-colored spots upon the sides of their abdomen. A pair of them and of the several other species of Sphinges that would at the same time be captured, might be preserved and placed in frames with which to ornament their homes, and to serve, perchance, as the commencement of a general collection of insects and of the fascinating study of entomology.

If the information asked of me be not of these tobacco worms, but of another kind that attack the roots at their setting, then the injury, without much doubt, is chargeable upon the ubiquitous cut-worm which we have been considering. Fortunately we have two ways — both pronounced excellent — of dealing with him, in order to prevent his immoderate use of tobacco.

The first, is dipping the young plants, before their setting, in a solution of white hellebore in water — one-fourth of a pound in ten quarts of water. A writer, from West Meriden reports, that, on the 22d of June, he set 3,000 plants, and on the following morning he took from one row of 180 plants 214 cut-worms. On the same day, in the same field, he set twelve plants dipped in the hellebore solution, which remained untouched, while the rows on either side were more than half destroyed. On June 24th, he set *over 2,000 plants treated in the same manner, of which he subsequently found but one plant eaten, and that but slightly.* He believed the hellebore to be a specific for the tobacco cut-worm.

The second, is poisoning with Paris green in the following manner: Four acres of tobacco plants were badly cut down, with sometimes as many as a half-dozen of the worms attacking a single plant. The owner went to a wood toward evening, and collected several kinds of leaves, which he laid in rows between the plants. The worms appeared to prefer the leaves of the chestnut for eating. The following day a large basketful of the chestnut leaves was gathered. These were dipped into a mixture of two gallons of water and two tablespoonfuls of Paris green, and a leaf put on each hill in the field, with a piece of ground or stone to hold it in place. The next morning, on examination, "the worms lay under the leaves like a hill of potatoes; they had eaten little holes through the leaves, and some were dead and others dying." The tobacco was then reset and no further trouble experienced from the cut-worms.

THE APPLE-MAGGOT.

An insect which has come under notice during the last twenty years as exceedingly destructive in many localities in the New England States to early apples, even surpassing the common apple-worm of *Carpocapsa pomonella*, is the *Trypeta pomonella* Walsh, known commonly as the "apple-maggot."

While the apple-worm, with which we have been so long familiar as the cause of the annoying and injurious worm-holes in our fruit, is the offspring of a small but beautifully marked moth, the apple-maggot, as its name imports, is the earlier stage of a fly.

The Fly.— The perfect insect resembles in form the common house-fly, but it is of a smaller size, being only about one-fifth of an inch in expanse. Its wings are white and glossy, and are marked in a pretty pattern with four blackish crossbands, the first of which is near the base, and the other three are connected upon the front margin of the wing and diverge behind. They are thought to represent somewhat the letters IF, with the I placed next the base and its lower end uniting with the lower end of the F. The abdomen has its first four segments broadly banded with white.

Life-history.— The parent fly, during the latter part of July or early in August, deposits a number of its eggs upon or near the calyx end of the apple, selecting often for its purpose fruit that has already been burrowed by the apple-worm. Upon hatching from the eggs the young larvæ enter the apple and commence to feed upon its pulp, not penetrating to the core, as does the apple-worm. Here they produce, at first, little irregularly rounded and discolored excavations of about the size of peas. These, when the larvæ are numerous, run together until the whole interior becomes a mere pulpy mass of disorganized material, or is entirely honeycombed with burrows in the more solid fruit. Meantime, the apple is entirely fair upon its exterior and gives no evidence of the destructive work being carried on within. Sometimes as many as a dozen larvæ are working together. Their operations are seldom noticed until in September. When they become full-grown, in the autumn, they escape from the fruit through small round holes that they cut in the peel, and enter the ground for pupation. In this condition they remain during the winter and do not emerge as flies until the following July.

From some recent observations it would appear that the larvæ sometimes are delayed in reaching maturity, and have been found feeding within the fruit so late as in the month of January.

The Larva — The larva in its greatest length measures about one-fifth of an inch, is without feet, and of a white or (as sometimes) of a yellowish or greenish color. The front third of its body tapers toward the minute, pointed head, which is armed beneath with its mouth-parts, consisting of two slender, blunt, coal-black hooks. The remainder of the body is cylindrical, with its terminal end blunt as if obliquely cut off, and bearing upon its slope four pairs of tubercles, of which one pair is longer than the other.

From this description the larva should admit of easy recognition whenever its operations are suspected in apples. The absence of feet and its pointed head will serve to distinguish it from the apple-worm.

Distribution.— The fly is a native species — one of the few of our insect pests which has not been introduced from Europe. It was first described by Mr. B. D. Walsh in 1867, from examples taken in Illinois, where it was discovered feding on thorn and crab apples, prior to any knowledge of its attack upon cultivated fruit. This new habit was first developed in, and was for some time confined to, the Eastern States and New York, but within the last year apples in different localities in Michigan have been attacked by it and entirely ruined.

The most frequent notices of it have been received from Vermont. In New Hampshire it has also become broadly distributed and ruined entire orchards. In Massachusetts it is quite destructive. Mr. L. L. Whitman has informed me that in his orchard at North Ashburnham he had hundreds of bushels of the finest fruit rendered worthless by it in 1883. Mr. Avery P. Slade, of Somerset, reports it the present year as honeycombing his apples. Several years ago its operations were observed in Connecticut, and it has been discussed in the late meetings of the State Board of Agriculture. From Brunswick, Maine, it is reported by Mr. T. S. McLellan as having made its appearance in his orchard in 1880, and infested all his sweet apples and most of the tart ones, such as the Haley, Hurlbut, Primate, Porter, etc. He had also heard of it from the northern part of Somerset county (*27th Ann. Rep. Maine St. Board of Agriculture for* 1883, p. 345). Mr. Robert H. Gardiner, President of the Maine State Pomological Society, states that the maggot was very destructive in 1883 to his Talman Sweet, Red Astrachan and Mother apples, but did not trouble other varieties (*Ib.*, p. 332).

In the State of New York it has proved a great pest at North Hempstead, Long Island, and in several of the Hudson river counties, and has also occurred in Delaware, Albany, Schenectady, Oneida, and Chemung counties, and is doubtless to be found in many other portions of the State. As yet we have no knowledge of its extension into New Jersey, Pennsylvania, the Southern or the extreme Western States.*

It appears, thus far, to be a local insect, and the fact that it is so should be an incentive for the use of every known means for the prevention of its distribution, that it may not become as generally distributed as is the apple-worm of the codling-moth.

Preference for Early Apples. — The insect in its past history, especially in its earlier history, has shown a marked preference for summer and autumn apples — always making its most vigorous attack upon sweet and mellow subacid early fruit. Yet it is known to have infested Spitzenbergs, in Brandon, Vt., and Baldwins and other varieties of winter apples, in Wallingford, Conn.

Remedial Measures.— This preference of the insect for certain varieties might be employed as a means for its destruction, by grafting the trees of an infested orchard to the varieties less liable to be infested, or, so far as known, entirely free from attack, and at the same time leaving two or three trees of its favorite fruit to serve as lures for concentrating the attack — the fruit of which

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[* In the Smith Catalogue of the Insects of New Jersey, 1890, it is included, with the note, "Locally injurious to apple, but seems confined to very few varieties."]

should be gathered at the proper time and be destroyed with all of the contained larvæ.

If it shall be found that any considerable proportion of the fruit containing the maggot falls to the ground as a consequence of the attack, then, of course, much benefit will be derived from gathering the fruit as fast as it falls and destroying it, or to give sheep the range of the orchard for feeding upon it. But as I have examined fruit offered for sale in the Albany market, presenting so fair and perfect an appearance as to prove beyond a doubt that it had been picked by hand from the tree, and yet teeming interiorly with nearly mature larvæ, it is highly probable that their presence does not cause the falling of the fruit.

Our study of this comparatively new insect depredator has hardly commenced. Careful observations are needed upon the time and manner of the larvæ leaving the fruit, and, in the earlier varieties of apples, when they enter the ground. In the later and stored varieties, it is important to know where they betake themselves for their pupation during the winter. Until these facts are definitely ascertained, together with others that are necessary to the completion of its life-history, we shall not be able to accomplish much toward mitigating the evil. We can prevent the attack of the apple-worm by showering the trees soon after the setting of the fruit, with Paris green or London purple in water, without the least possible chance of injuring the fruit through the poisonous application. But the month of July — when the Trypeta deposits the eggs that produce the apple maggot — would be too late to apply with safety such substance to the fruit, already nearly full-grown and soon to be eaten.

Perhaps, for the present, the best results may attend our efforts to destroy the insect in its pupal stage. If examination should show us that the pupation ordinarily takes place in the orchard, beneath the infested trees, then we may reach it there. But if the pupation follows the gathering and storing of the fruit,— as seems more probable,— then the discovery of the retreat of the larvæ should give us the means for destroying them.

Desiderata in its Life-history. — In my forthcoming report [second in this series] I have indicated several points upon which knowledge is needed toward the completion of the life-history of this insect. I will introduce them here, accompanying them with the earnest request that you will each, as opportunity may offer, make contribution, to your ability, toward the desired knowledge of this already great pest of our orchards, and which gives every promise of soon becoming still more pernicious. It is manifesting a tendency to widespread distribution, and an unusual adaptability to different varieties of the apple. It would not be surprising if it soon attacked our pears.

Are the eggs of the fly distributed over the apple or placed only near the calyx end?

Do the larvæ occur in apples which have not been perforated by the apple-worm of the codling-moth or by some other insect?

How long a time is required for the larvæ to attain their growth?

How do the larvæ leave the fruit,— by several holes through the skin, through a single hole, or only when the apple has become broken down from decay?

When entering the ground for pupation, to what depth do they bury? This could be ascertained by providing them with a box containing a few inches of earth for burial.

Are both the early and late fruits similarly attacked by this insect? It is possible that the larvæ reported in winter apples may be of a different species.

During what months and portions of months are the larvæ to be found in the apples?

Are the puparia to be found at the bottom of apple barrels, or bins in cellars, or between the staves or boards? Should any doubt exist of the identity of the puparia found under such conditions, the fly should be reared from it to determine the point.

[See an admirable study of this insect which has since been made by Professor F. L. Harvey, and published in the *Report of the Maine State College Agricultural Experiment Station* of 1889, pp. 190-241, plates 1-4. In this paper, the description of the several stages, history, distribution, life-history, etc., of the insect are fully presented, together with the most effective means known for arresting its injuries.]

THE ASPARAGUS BEETLE.

Information upon this insect is desired, and may very properly be given at the present time, as it has but recently extended its depredations into Massachusetts. It is a much easier task to arrest the spread of a new insect pest, than to control its ravages after it has taken full possession of its new territory and perfectly adapted itself to its new conditions. It is therefore important that the insect should be known, so that it may at once be recognized, and prompt measures resorted to, in order to check its increase.

Description.— In general shape and size it resembles the well-known cucumber-beetle, *Diabrotica vittata*, but it is somewhat longer, being about a quarter of an inch long, and its body is more elongated from its parallel sides. It has a black head, and a finely punctured tawny-red thorax, marked with two black spots upon its crown. The lemon-colored, punctured wing-covers are usually broken into three spots each, by a black stripe along their junction, a black transverse band a little beyond their middle, and an interrupted one near their tips; outwardly they are bordered with orange. The body beneath and the legs are shining black. The elytral markings as above given, suggest to some the representation of a black cross, for which reason it is sometimes known, in England, as the "cross-bearer." Other examples of the beetle not unfrequently met with, may be described as having their wing-covers blue-black, margined and tipped with orange, and with three small yellow spots in a line down the middle of each cover.

Its Associates.— The scientific name of the beetle is *Crioceris asparagi*. It was first described by Linnæus, nearly a century ago. It belongs to the same destructive family of the *Chrysomelidæ* with the striped cucumber beetle, the cucumber flea-beetle, the grapevine flea-beetle, the Colorado potato-beetle, etc. For a long time it was the only representative of its genus in this country, but another species has recently been introduced from Europe — *Crioceris* 12-*punctata*, — which was first observed in the vicinity of Baltimore in 1881, and already gives indication of becoming quite destructive to asparagus.

Its Introduction. — *Crioceris asparagi* is an European species, which our commercial and other relations with the Old World have brought to our shores, in common with a large number of our most destructive insect pests. It was first noticed upon the eastern end of Long Island, at Astoria, in the year 1859, and it is worthy of note that, in the same year, the first specimens of another very injurious insect, also introduced from Europe.— the cabbage butterfly, *Pieris rapæ*, was taken, in the city of Quebec. As early as 1862 the beetle had spread over all the asparagus plantations of Long Island. The following year it was attacked by a parasite which destroyed its eggs, and doubtless aided much in arresting its increase. The parasite was not described. It probably disappeared before it could receive scientific attention, for nothing seems to be known of it at the present.

Its Distribution.— In 1868 the beetle had extended its range into New Jersey, where, in the third year of its observation, entire beds were ruined by it. Its rate of distribution, in its earlier years, appears to have been about twenty miles a year, but fortunately this has not been sustained. During the twenty-five years that have elapsed since its introduction, it has not shown a disposition to extend far from the sea-coast, nor to a great distance from New York city, as its center of operations. Serious injuries from it have only been reported from Long Island, the vicinity of New York city, Southern Connecticut, New Jersey and Eastern Pennsylvania. It has not been seen at Albany, although during the last year I have received examples of it collected at the New York State Agricultural Experiment Station, at Geneva — a locality that lies to the westward of the central portion of the State. An equal extension from New York could carry it into any portion of Massachusetts. It is a matter of surprise to me that it has not made, long ere this, formidable demonstration in the eastern — particularly the seaboard — portion of your State.

Its Natural History. — The history of *C. asparagi* is, in brief, as follows: The beetles destined to continue the species survive the winter in dry, sheltered places, as beneath bark, in crevices of wood, and under the clapboards of buildings. Simultaneously with the appearance of the asparagus shoots in early spring, they emerge from their winter quarters, and commence to feed upon the tips of the plants. The sexes pair, and the female deposits her eggs upon any portion of the exposed shoots. The eggs hatch in an average period of eight days. The larvæ eat voraciously and grow rapidly, so that they complete their growth in about twelve days. They then leave the plants and enter the earth for a short distance, or merely conceal themselves beneath dead leaves or other material on the surface. Constructing a slight cocoon, they undergo their transformation, and remain in their pupal state for about ten days. Thirty days complete the cycle from the egg to the perfect insect. Almost as soon as the beetles emerge they pair, as the sexual instinct is strongly developed in them, as is shown in the frequency in which they come under our observation mated. The eggs are then deposited, and the beetles continue to feed for several days upon the plants, eating holes into the bark of the more tender branches; one was found by Dr. Fitch to feed for a fortnight in confinement. A second brood results from these, appearing about the first of July, followed by a third, probably in August. Hence we have the larvæ and the beetles with us, in their successive broods, through the spring and summer, into September.

Remedies.— Among the remedies proposed and employed against this insect are the following: Hand-picking, when not too abundant, and beating them from the plants into a broad pan of water and kerosene.

Employing fowls to hunt them, which are very eager in catching and eating the beetle, and are not injurious to the plants.

Cutting away all the young seedlings in the spring at the time when the beetles are about to deposit their eggs, thus forcing them to lay their eggs upon the new shoots, which are cut and sent to market before the hatching would occur.

Benefit has been derived from cutting down the seed stems at the close of the season, as also once or twice during the season, leaving the beds bare and smooth.

But, undoubtedly, the best method with which to meet this insect is by the lime application proposed by Mr. A. S. Fuller, of Ridgewood, N. J., as the result of his personal and successful experience. The freshly-slacked lime, he states, may be conveniently scattered over the plants by using an old broom for a duster, or a Paris-green sifter. With a pailful of the lime, a man could in a short time dust an acre of asparagus. It could best be applied in the morning while the dew is on, for then a portion will adhere to the plants as well as to the grubs, and during the day or days following, it will be constantly dropping down or blowing about among the leaves and branches, thereby making the escape of any of the larvæ all the more uncertain.

For the past sixteen years, Mr. Fuller had, according to his statement, used lime as described, upon his asparagus beds, to keep the insect in question in check, and it has done it so effectually that about one application every alternate season was sufficient. Not only is lime cheap and readily procurable everywhere, but it is of benefit to the asparagus roots. It has also the additional merit as an insecticide, that it can be used upon the young plants while they are being cut for market, for the destruction of the first brood of larvæ while Paris green or London purple may not safely be employed.

THE GRAPEVINE "THRIPS."

Frequent complaints are made of the damage done to grapevines, from an attack upon their leaves by the "Thrips." This is a popular name — but an incorrect one as will be shown hereafter — which has obtained widespread currency among vine growers for some small (about an eighth of an inch long), slender, spindle-shaped, parti-colored leaf-hoppers, which are very destructive to the foliage of grapevines. They abound upon the leaves in their three stages of larva, pupa, and perfect insect, in each of which they are injurious. Their injury to the leaves is caused by puncturing them with their beak or proboscis and feeding upon the sap. They are usually to be found upon the under surface of the leaves. The punctures first produce small discolored spots, which are multiplied over the surface, and rapidly increase in size by their running together and by the greater suctorial power of the growing insect. Later they become large brown blotches, which, if the insects are numerous, extend over and embrace the entire leaf, causing it to dry,— appearing as if scorched by fire,— to die, and fall from the vine. As a consequence of this partial defoliation, the fruit is dwarfed and its ripening interfered with, and the death of the vine may follow if the insects have been very numerous. These little creatures belong to the order of HEMIPTERA, which embraces a large number of our destructive pests, as the plant-lice (*Aphididæ*), the scale-insects and the mealy-bugs (*Coccidæ*), the grape Phylloxera, etc.— all of which subsist only upon liquid food, but fully equal in destructiveness to those provided with formidable biting jaws.

Several species of these little leaf-hoppers are frequently associated upon the grape leaves. They belong to the genus known as *Erythroneura*, and the more common one is that described by Dr. Harris in 1831, as *Tettigonia vitis*.* It is about one-tenth of an inch long, of a pale yellow or straw-color, with two narrow red lines on its head, and scarlet bands upon its thorax and wing-covers. It appears in June, in its larval stage, when it may be found quietly resting upon the leaves, with its beak thrust therein, unless it be disturbed, when it hops briskly to another leaf. They cast their skins from time to time as they increase in size, and numbers of these white, empty cases may be found fastened to the under surface of the foliage or scattered on the ground beneath. In July they assume their pupal form. In August they mature and acquire wings; when, if the vines are shaken, they may be driven up in swarms, but only to return and resume their destructive work. The winged insect survives the winter, hibernating among the dead leaves or in other sequestered places. The following spring, in the month of May, it comes forth from its retreat, and deposits its eggs upon the leaves of the vines for another brood.

The *Thrips* proper is an entirely different insect. It is a smaller insect than the grapevine leaf-hopper, with long and narrow wings without veins and bordered with long fringes— the two pairs of about equal size. There are a number of species united in the family of *Thripidæ*, the location of which, in our classification, has been the occasion of much discussion and is still in doubt. By Halliday, it was set apart in a distinct order, under the name of THYSANOPTERA, and this arrangement has been accepted by many entomologists. Dr. Packard and others regard it as properly placed among the HEMIPTERA, to some of the families of which it seems to have a close affinity. Their habits vary greatly; for while many of the species are unquestionably vegetable feeders, and injurious in their operations, others, from their carnivorous propensities, are serviceable in their destruction of gall-insects, the eggs of the curculio, the red spider (*Tetranychus telarius*), the clover-seed midge (*Cecidomyia leguminicola*), the wheat midge (*Diplosis tritici*), and other insect pests.

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* Now *Typhlocyba vitis* (Harris).

The method commonly resorted to for the prevention of the ravages of the so-called "Thrips" in graperies, has been fumigation with burned tobacco. This has proved to be partially successful. A still better method has been for some time employed in France, but not to my knowledge to any extent in this country. It is the vaporization of a strong extract of tobacco. One who has thoroughly tested it bears this testimony to its efficacy: "Ever since I adopted it, it has been absolutely impossible to find a 'thrips' in my houses, and other insects have likewise disappeared." The following method of use is given:

Every week, whether there are insects or not, I have a number of braziers containing burning charcoal distributed through my houses. On each brazier is placed an old saucepan containing about a pint of tobacco juice of the strength of fourteen degrees. This is quickly vaporized, and the atmosphere of the house is saturated with the nicotine-laden vapor, which becomes condensed on everything with which it comes in contact. When the contents of the saucepan are reduced to the consistency of thick syrup, about a pint of water is added to each, and the vaporization goes on as before. I consider a pint of tobacco juice sufficient for a house of about 2,000 cubic feet. The smell is not so unpleasant as that from fumigation, and tobacco juice can be used more conveniently than the leaves.

When the operation is completed, if the tongue is applied to a leaf, one can easily understand what has taken place, from the very perceptible taste of tobacco.

The process requires to be repeated in proportion to the extent to which a house is infested. Such troublesome guests are not to be wholly exterminated by a single operation. A new brood may be hatched on the following day, or some may not have been reached on the first day, so that the vaporization should be frequently carried on, until the insects have entirely disappeared, and after that it should be repeated every week in order to prevent a fresh invasion.

The tobacco juice of the proper strength is purchasable at the tobacco factories in France for about fifteen cents (of our money) a quart. Its expense, at this rate, would be but about twenty-five cents a week for a grapery of about fifty feet by sixteen and ten.

A strong infusion of tobacco leaves, made by boiling, would be a substitute for the above. It might be prepared in quantity and evaporated to the proper degree, for convenience of keeping and for ready use.

Although the so-called thrips — it might properly be designated the "grapevine leaf-hopper"—is more abundant within the shelter of graperies than elsewhere, still in favorable seasons and in certain localities, it is a great pest in vineyards, where it is less amenable to remedial measures. Early in the season, while yet in its larval stage, benefit has been derived from showering the lower surface of the leaves with an infusion of tobacco or soapsuds, or of both combined. A still more effectual application should be spraying with an emulsion of kerosene oil and common soap, made after the formulas given for its preparation.

Another method has been used for destroying this insect, with good results, it is stated. A long strip of building-paper is smeared with coal-tar on one side, and stretched between the rows, when, with a brush, the insects are driven up from the vines against the sticky surface, to which they adhere. Two men and a boy can go over a vineyard in this manner in a short time, and a few repetitions will nearly exterminate them.

The Rose-leaf "Thrips."

This little pest, which is almost always present with us during the summer months, to mar, if it does not destroy, the leafage of our rose-bushes, is a near relative of the insect which we have been discussing. It is the *Tettigonia rosæ* of the Harris reports,*— a small, yellow-bodied leaf-hopper, with white and transparent wing-covers and wings, and brown eyes and feet. Its life-history closely resembles that of *Erythroneura vitis*, of the grape.

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* Now, *Empoa rosæ* (Harris).

Perhaps the best preventive of injury by this insect is an infusion of tobacco, prepared in the following manner: Where the tobacco stems can be procured, place some of them in a vessel of the capacity of a common pail and pour boiling water upon them until they are covered. Allow it to stand over night, and when used dilute it with five times the quantity of water and apply it to the underside of the leaves with a garden syringe, or force pump with a rose nozzle. The application should be made in the evening, or early in the morning, and, particularly, early in the season, before the injuries become noticeable except from close examination, and as soon as the young larvæ, looking like little white specks, are discoverable on the underside of the leaves. The showering should be repeated from time to time so long as the insects remain or the effects of their presence are noticeable.

I had intended asking your attention to a few other insect pests which are annually demanding heavy tribute from you, and which you are voluntarily paying,— not necessarily, for recent discoveries in economic entomology have given means which only need to be properly used in order that the burden of insect injuries shall be materially lightened; but I have already exceeded the time allotted for my paper.

May I hope that the details presented — some of which I fear may have been found dry — may not have greatly wearied you.

OUR INSECT ENEMIES AND HOW TO MEET THEM.

[Read before the New Jersey State Board of Agriculture at its Annual Meeting at Trenton, February 1st, 1889.]

It is, I believe, conceded by every intelligent person that agriculture is the greatest of human industries, as, of necessity, it serves as the basis of all others. A sparse human population might exist upon this globe without tillage of the soil, but the man would not be very far in advance of some of those vegetable organisms which are endowed with powers that enable them to seize and devour, and, it is thought, to digest animal food. All literature, science, and the arts are dependent upon it — yes, civilization itself. It was, so far as we have knowledge, the primal privilege granted to man, when he was made in the image of his Maker, ere he was driven from Eden and doomed henceforth to toil, and in the sweat of his face to eat his bread.

Are figures needed to show the importance of agriculture? Here, in our own country, so remarkably adapted by soil, climate, topography, and extent of territory to grow to perfection whatever crop may be grown in any of the temperate regions of the globe, as well as in some of the semi-tropical ones,— of our present population of sixty millions there is an aggregate agricultural population of twenty-six millions. The total value of farm products in 1886 was $3,727,000,000 — nearly three and three-fourths billions — an amount quite beyond the need for home consumption, and its surplusage — one-tenth of the amount — was sent from our shores, mainly to supply the needs of Europe.

May you not feel an honest pride in an industry that can show such results? Is it not one that should be respected by every man, in whatever pursuit he may be engaged. Nay, more. Is it not one that should be cherished and encouraged by every possible means, as the conviction is being more strongly impressed upon each careful student of political economy, that from the products of our broad territory are the less highly favored nations of the globe to be, hereafter, more and more largely fed? Whatever, then, may militate against this interest is deeply to be deplored. Not only must it, for our individual needs and for the welfare of the nations, be sustained, but it must be enlarged. Will this naturally follow, in continued progression, with the increase of our population and the occupancy and tillage of the extended tracts of uncultivated land in our Western States and Territories? No; for vast arid regions are being already reached, where productive crops can only follow costly systems of irrigation; and not many years will elapse before the virgin soil of the West will no longer respond with the prolificacy of its first receptiveness. Nature, at the outset, prodigal of her wealth, gives up her accumulated stores of centuries for the asking; but they are not inexhaustible, and sooner or later her golden returns will cease.

It is evident to all, that in the Eastern United States this condition even now prevails. The husbandman can no longer tickle the earth with his hoe or plow and have it smile into a bountiful crop or harvest. Where, fifty years ago, forty bushels of wheat could be grown from an acre, now, with even increased labor, but twelve bushels can be taken. Grain can no longer be cultivated with profit, and other crops are in the same category.

Other causes, in addition to an exhausted fertility of the soil, have concurred in the prostration of the agricultural interests in our Eastern States, and to send up the cry so often heard, "farming does not pay." Prominent among these causes is the competition to which the eastern farmer is brought with the immense production of the fertile West — its comparative low cost of production and the low rates of transportation by which it reaches and commands the markets which he formerly controlled. The crops on which he hitherto relied, and the methods of agriculture which he and his fathers before him had remuneratively followed, must be abandoned. There must be a change of base — a new departure. Absolute necessity compels a movement all along the line, and the successful farmer of the future will be he who joins the advance, and strives to keep pace with the foremost in the march.

The fact can not be denied that a rapid advance is being made at the present time in the science of agriculture (we are no longer afraid to call science to its aid) through the investigations and teachings of our Agricultural Colleges and Experiment Stations. Well it is that the results of these investigations are being brought before our farmers very efficiently, through the Farmers' Institutes, which are being so successfully conducted in several of our States. It having been my privilege to attend a number of these institutes, it seems to me that their teaching may be summed up under these three heads: How to feed and care for farm stock; how to feed the soil (this embraces its cultivation), and how to protect and preserve for use the products of farm labor. Under these will naturally group themselves all of the prominent topics of discussion, as food and shelter and care of stock, production and preservation of manures, artificial fertilizers, rotation of crops, the products of the dairy, stock breeding, fruit growing, ensilage, and the like.

I need hardly state this truism, that all the labor, care, and money that you expend in the effort to produce the conditions calculated to give you the best possible returns, will be lost, just so far as you fail, through neglect or lack of knowledge, to secure the resultant products to which you are entitled. In many directions are you chargeable with this neglect, but suffice it for the present if I refer only to that particular one, of which, in the invitation given me to address you at this time, you virtually confess yourselves at fault, and make promise of doing better in the future, if I will point the way.

Your secretary has suggested as my topic, "Entomology in the Eastern United States; the importance of a more comprehensive knowledge of entomology to the farmer and fruit-grower, with some suggestions as to th esimplest and quickest way of getting this knowledge before those interested." This, I think, is embraced under the brief title that I have selected for my paper.

Economic Entomology.

The losses resulting from insect depredations in the United States are very far in excess of those sustained in any other portion of the globe. The aggregate of annual losses to agricultural products is startling when an attempt is made to estimate it, while in exceptional years of some unusual insect abundance, the computations that have been made from time to time would seem to be almost beyond belief.

The magnitude of these losses has driven our people to seek protection from them in the study of insect pests and their habits. Hence it is that within the last fifty years a new science — that of Economic Entomology — has had its birth among us, a rapid growth, and a present development quite in advance of any of the older nations of the world. It may be defined as "the study of insects in their relations with man — of their character, habits, transformations, food-plants, enemies, diseases, etc., with a view of affording protection from the injuries of a large portion of their number, and of utilizing the benefits derived from a minor portion."

Our Eastern States gave early recognition of the value and importance to the Commonwealth of this department of natural science. The first publication issued under State authority was the "Report on Insects Injurious to Vegetation," by Dr. T. W. Harris, in 1841. The commencement of a series of "Reports on the Noxious, Beneficial and other Insects of the State of New York," in the year 1855, by Dr. Asa Fitch, under the auspices of the New York State Agricultural Society, gave a new interest and impetus to the study, and was doubtless instrumental in initiating similar investigations and publications by Mr. B. D. Walsh, in 1867, in Illinois, and by Professor Riley, in 1868, in Missouri,— in the first-named State, continued by Drs. LeBaron and Thomas, and through Professor Forbes up to the present time.

In 1878, at the termination of Mr. Glover's labors as Entomologist to the United States Department of Agriculture (commenced in 1863), an entomological division was established by the Department and organized with Professor Riley as Chief. The work of the division, generously sustained by Congress, has continued to be prosecuted with signal ability and success. Its publications, through annual reports, bulletins, and more lately, a monthly periodical, have been of a high order and of eminent service to the agricultural interests of the United States.

In 1877, a special Entomological Commission, to consist of three skilled economic entomologists, was authorized by Congress, for the purpose of investigating and reporting upon the depredations of the Rocky Mountain locust of the Western States and Territories, and the best practicable method of preventing their recurrence or guarding against their invasions. The investigations of the commission were subsequently extended to the cotton-worm of the Southern States, and to some other insects whose widespread ravages had given them a national importance. The labors of this commission were attended with valuable practical results, and have given us a large addition to our literature in four octavo volumes and seven bulletins.

In 1880, the State of New York resumed entomological investigations, after an interval of ten years — they having been interrupted in 1870 by the impaired health of Dr. Fitch.

There is not the time in which to refer to other entomological work done more or less directly under State authority in connection with agricultural and horticultural societies and agricultural colleges, a long recital of which might be made. It is fitting, however, that I should not omit mention of the impetus which has been given to entomological research in the recent establishment, under the "Hatch Bill," of Agricultural Experiment Stations in at least twenty-eight of our States. In twenty-two of these so far as I know, an entomologist charged with the study of insect depredations and methods for their control has been appointed, and, it is believed, that the same indispensable work will be entered upon in each of the stations, as soon as competent persons can be found to meet the requirements of the position. Most heartily do I welcome this large addition to our hitherto small body of economic entomologists, and very bright are my anticipations of a greatly accelerated future progress, and of the benefit to result therefrom to the agricultural interests of our country.

IMPORTANCE OF ENTOMOLOGICAL STUDY.

Years ago, when insects were collected with no higher motive than the possession of a fine cabinet, or when their study went no further than giving them name and classification, it was customary to ridicule the pursuit as trivial, petty, unworthy of the dignity of a man. All insects, whether bees, butterflies, or beetles, were "bugs," and those who collected them were "bug-hunters."

To-day, the application of the knowledge which has been so long accumulating, to advancement in agriculture, horticulture, sylviculture, etc., has given to the study of entomology an importance which is recognized as second to no other department of natural history. It is being everywhere prosecuted with vigor, by the General Government and by the States, as we have indicated, and by private individuals, in compliance with the wide-spread demand for efficient means of protection from insect ravages — for a release from a taxation upon the products of the farm which is most burdensome, and the compulsory payment of which brings with it none of the compensations that ameliorate the payment of other taxes, in the protection that they afford to property, and the privileges and comforts that they bring to our homes; it is an entire loss.

The importance of the study of our insect enemies and their habits, may perhaps, be better seen from a few considerations, which we will present.

The Secrecy of Insect Depredations.

Probably that crop can not be named that may not be impaired one-tenth of its full value without the knowledge of insect presence or recognition of insect injury. Such secret injury is usually due to the operations of root-feeding insects, which are numerous in classes and in species, and from their subterranean life, do not fall under ordinary observation. Among these are plant-lice, the caterpillars of various moths and the larvæ of many beetles and flies, known often only to entomologists who have made a study of their early stages.

It is not an unusual occurrence that serious and evident insect injury is inflicted through a term of years, while the author of it remains unknown. An illustration of this may be found in the failure of the red clover to produce its seed, which for a long time was ascribed to the want of fertilization by bees, but was discovered a few years ago to be the result of the feeding within the blossoms upon the forming seed, by the larvæ of the clover-seed midge. *Cecidomyia leguminicola.* Certain injuries to several of our fruits causing their gnarling and deformation, which have long been a mystery to me, have found their explanation during the past year, in the punctures made by a minute caterpillar — a *Coleophora* — which, always concealed within the peculiar case that it carries with it — if seen, as it doubtless often has been by the fruit-grower, would not be suspected of belonging to the insect world. Another new pest is baffling me and eluding my efforts for its discovery, through its secret girdling (believed to be at night) with a circle of incisions the tips of currant bushes in certain localities in New York, and causing them to break off and fall to the ground. There are cut-worms which leave their hidden retreats beneath the ground or shelter of rubbish, only after night-fall and climb into grapevines, where they cut off the clusters of the grapes, and into fruit trees, severing the stems of leaves and fruit. Numerous other insects intensify the loss that they occasion by the secrecy with which it is inflicted, and the consequent difficulty of meeting it. Of this class are the burrowers within the stems and stalks of plants or in trunks of trees, the numerous and destructive bark-borers which feed within the vital sap-wood, and leaf-miners, so minute as to find ample feeding ground in the range and concealment given them between the surfaces of a leaf.

THE SMALL SIZE OF INSECTS.

Nature often teaches us the lesson, of which we need frequently to be reminded, that size is no criterion of importance. Thus, among our insect foes, many of the most injurious are among the smallest of their class, and, hence, we have the seeming paradox — "the smaller the insect the greater its capability for harm." In confirmation of this we may cite the grapevine Phylloxera (*Phylloxera vitifoliæ*) which was first discovered by Dr. Fitch, in Washington county, N. Y., in the year 1854,— was introduced in France in 1863, and subsequently multiplied to such an extent as to threaten the entire destruction of that most important interest to France — grape culture. In 1879, nearly 3,000,000 of acres of infested vines had been taken up, destroyed, and the land appropriated to other uses. For several years, annual appropriations amounting to nearly $200,000 were made by the government for Phylloxera investigations, and a reward has been offered of 300,000 francs ($60,000) for the discovery of an effectual remedy.

And yet it is but a plant-louse, one of the smallest of its kind, and a mere dot — a microscopic object in several of its stages.

The diminutive size of the insect does not permit his exclusion from your crops by the ordinary means that give protection from the incursion of domestic animals that at times break their inclosures and invade your fields, although the injuries wrought by the latter may hardly admit of comparison with those caused by the former. True, ditches are sometimes dug and barriers built by western farmers to stay the marches of the army-worm and the chinch-bug in seasons of their excessive abundance, and valuable crops have been, by these means, rescued from threatened destruction. But, as a rule, the armies of destructive insects which spring out of the ground or drop upon you as if from the skies, must be fought by methods which are only to be learned from careful and continued study of the secret operations and wily ways of the species with which you have to contend.

We err when we regard all insects as small, notwithstanding that one of the definitions given by Webster of an insect is "something small or contemptible." But our best lexicographers are sometimes open to just criticism, as, for example, when Dr. Johnson has given as a definition of *net work* lest its meaning might not be perfectly clear to the simple-minded — "anything reticulated or decussated at equal distances with interstices between the intersections." True, the insect is small in comparison with our domestic animals and most of the mammals, yet there are large insects as well as small, for we have gradations among them not less marked than in other classes of animated nature. It has been computed that the average size in the animal kingdom — with the smallest known protozoan at one end of the line and the flat-back whale of the Pacific coast with its ninety-five feet of length and 294,000 pounds of weight, at the other, is to be found in the common house-fly, *Musca domestica*. All insects exceeding this in size may properly be called *large;* those only that are less in size, *small*. Does this seem surprising? Remember that there lies a vast world of living beings, the limit of which is not yet defined, which the unaided eye does not see, and which the microscope must call up to our wonder and admiration, just as, in the other direction, each successive enlargement of the object glass of the telescope brings to our view from the depths of boundless space, suns and systems and galaxies of systems before unknown and unsuspected.

Number of Insects.

Insects, in number of species, exceed by far all the rest of the animal kingdom combined. They are believed to be ten-fold more numerous than all of the mammals, birds, fishes, reptiles, myriapods, crustaceans, worms, molluscs, radiates, and protozoans, united. At the latter part of the 17th century, they were estimated at 10,000 species. During the last 100 years the discovery of new species has been very rapid, and in 1881 there had been described and catalogued throughout the world 320,000 species, while many thousands were in collections awaiting name and description — 12,000 in a single collection — that of the British Museum. Judging from past discoveries, we may venture to claim that if all the species inhabiting the world were known, the number would reach *one million*.*

If, from distinct species, we descend to the consideration of individuals, figures are of no service, for the numbers that we should have to employ would be simply incomprehensible. I have seen at a glance, in a locality near Albany, within a small extent of roadway, of a single species of a snow-flea — a *Podura*, more individuals, as computed by me, than there are human beings on the entire face of the globe. A single small cherry tree of ten feet in height, infested with a plant-louse — one of a row similarly infested — was estimated by Dr. Fitch, by counting the number on a single leaf, the leaves on a branch, and the branches on the tree, to contain the amazing number of 12,000,000. Although this may strike one as a large number, yet few, if any, have any approximate idea of what a million means. Were I to count as rapidly as I could enunciate, simply naming the figures in their order and connection, omitting repetition of "hundred" and "thousand" where they occur — thus saying, "nine-seventy-three-four-eighty-one," instead of "nine hundred and seventy-three thousand four hundred and eighty-one," and con-

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[* Lord Walsingham has raised this estimate to *three millions*.]

tinue thus counting for ten hours a day, it would require twenty-eight days to count a million, and consequently, eleven months of such labor (an obvious impossibility, for utterly beyond human power of endurance) to have counted the aphides upon that little cherry tree.

RAPIDITY OF PROPAGATION.

The rapidity of propagation shown in some insects, is also without a parallel elsewhere. Perhaps, in the aphides or plant-lice, it attains its maximum, where successive generations of living young, all of which are females, continue to be produced throughout the summer months, without the presence of the male, by a process which has been compared to, and, indeed, styled, budding. Professor Riley, in his recent studies of the hop-vine aphis, *Phorodon humuli*, has observed thirteen generations of the species in the year. Now, if we assume as the average number of young produced by each female to be 100, and that every individual shall attain maturity and produce its full complement of young (which, however, never can occur in nature), we would have, as the number of the twelfth brood alone (not counting those of all of the preceding broods), 10,000,000,000,000,000,000,000 (ten sextillions) of individuals. Where, as in this instance, figures fail to convey any adequate proper conception, may I ask you to take space and velocity of light as your measures? Were this brood, as above given, marshalled in line with ten individuals to a linear inch, touching one another, the procession would extend to the sun (a space which light traverses in eight minutes), and beyond it to the nearest fixed star (traversed by light only in six years), and still onward in space beyond the most distant star that the strongest telescope may bring to our view, to a point so inconceivably remote that light could only reach us from it in twenty-five hundred years. How fortunate it is for the human race, that in view of such amazing capabilities of increase in the insect world, so many counter-checks have been provided by Providence for the prevention of unrestricted development in a single direction, that all nature may still work together in harmony, when viewed in its broadest aspect.

THE VORACITY OF INSECTS.

The larval stage of many insects is apparently one of incessant feeding. It may be doubted of some if they ever sleep, or even indulge in rest unless disturbed while feeding, or during their molting periods, when time is demanded for the changes required in the casting off of a skin distended to its utmost capacity, and the formation and assumption of a new one capable of further extension. Their voraciousness and rapid growth may be shown in the statement of two facts: A certain flesh-feeding larva will consume in twenty-four hours two hundred times its original weight,— a parallel to which, in the human race, would be, an infant consuming in the first day of its existence, fifteen hundred pounds of nutriment. There are vegetable feeders,— caterpillars, which, during their progress to maturity, within thirty days, increase in size ten thousand times. To equal this remarkable growth, a man at his maturity, would have to weigh no less than forty tons. In view of such statements, need we wonder that the insect world is so destructive and so potent a power for harm.

CAN INSECT RAVAGES BE PREVENTED?

I have attempted, from a few considerations, to show the importance of insects in their relation to agricultural pursuits; that losses appalling in their magnitude are inflicted by them; and that these losses are steadily on the increase. What can be done? Can they be prevented? We answer, no, not entirely, but they may be controlled. My studies of twenty-five years have taught me that the insect does not exist, the injuries of which may not be greatly diminished when we have learned its entire life-history and its habits. Each one, when we know it fully, discloses some vulnerable point, and a particular time in one of its four stages of existence when it may be attacked to the best advantage. I assuredly speak within bounds when I say, what could not with truth have been said twenty years ago, that with our present knowledge and with the means now at our command, in the insecticides and preventives known, and apparatus and methods for their use, we can, if we will, lessen insect depredations to the extent of at least one-half of their present magnitude. What an addition this would be to the national wealth and to individual well-being!

How to Meet our Insect Enemies.

Turning now to the practical part of my paper — how may we best meet our insect foes? I will name some of the methods by which this may be done.

High Culture.— First and foremost, I would recommend high culture. Just in proportion that the vigor and growth of a crop is promoted, to the same extent there is given to it the ability to resist and overcome the effects of insect attack. While the feeble plant succumbs, the vigorous one will flourish and mature despite the drain upon it. It will have a resistant force to sustain it, just as health and a well-developed body may exclude or triumph over disease. And then, again, the weak, sickly, or diseased plant, made so either through neglect of cultivation or lack of needed fertilizing material, directly invites insect attack. The peculiar odor that emanates from it when in this condition, is at once detected by the insect, and serves to draw it from distances that seem almost incredible. Insects, that they may readily find the food-plants on which they are destined to feed and those upon which they are to deposit their eggs for the continuance of their species,— as if in compensation for a feeble, short range, and quite imperfect vision, have been endowed with a sense of smell which is marvellous in its acuteness, and is without parallel in any other class of the animal world. It is believed by some entomologists that many of our insect pests never make attack on healthy vegetation, but only on that which is diseased; as if in the economy of nature they were specially commissioned to hasten destruction and decay; and among these they would place many of the bark-borers that infest our fruit and shade trees, with which it seems almost hopeless for us to contend.

Clean Culture.— A large proportion of our insect pests survive the winter within such shelter as they may find in decaying wood, sticks, boards, or rails lying on the ground. Dead vines, stalks (particularly if they are hollow), twisted leaves, etc., afford excellent hibernating places for the adult forms of many of the Hemiptera (commonly known as "bugs"), from which they emerge and deposit their eggs in the spring, simultaneously with the commencement of vegetation, when attack is ever most harmful. It is obvious, therefore, that much benefit will result from gathering in the autumn, all rubbish, dead vegetable matter, and other refuse material, and burning it with all the insects that it is harboring; or if this be regarded as wasteful, then so compost it, that the compost pile shall not be, as we believe it often is, a nursery for insect pests that in the injury that they inflict more than counter-balances the manurial value.

A knowledge of Insect Pests. — A favorite maxim of my school days was, "*Nosce te ipsum*" — know thyself. One equally important in later years, of broad application, but of special importance to the agriculturist, is, *know your enemies.* How can you successfully meet them, check their operations, prevent their attack, or destroy them if need be (for, fortunately, there are no laws against the killing of insects), unless you know who your foe is, when his attack is to be made, where it is to be made, and what he purposes to do. To know this is to be forearmed and in readiness for the fight. Are your insect enemies so many that you fear that you can not make their acquaintance? Do not be frightened at the seeming magnitude of the task, as if you were brought to contend single-handed, with the perhaps 20,000 distinct species which your State harbors. Some of these are your friends, others are at least harmless, while a large proportion are but comparatively injurious. In a list of 100 species, there could, I think, be named all of those which it would be to your particular interest to know and to study. These, at least, you should know by name, so that you may confer with one another in relation to them, and communicate with your entomologist or other scientist of whom you might desire information — such as the best approved remedy or preventive to be employed. The common name which every destructive species, known for any length of time, has received, would be sufficient for your use, but it would be advisable, so far as you conveniently could, to acquire also their scientific name, as a help to you, if you purpose to add to your own observation, the study of what has been learned and written of them by others. To illustrate what I mean: Your apple trees, perchance, are not doing well — something is the matter with them — probably an insect is the cause. What insect is it? Is the apple-tree aphis infesting the buds or curling and distorting the leaves? Is the bud-worm tying up and consuming the young foliage just as it puts forth? Is the oyster-shell bark-louse pumping out through hundreds of thousands of tubes the life-blood of the tree? Is the flat-headed borer tunneling the limbs, or the round-headed borer working at the base of the trunk? Are any of the tiny bark beetles burrowing into the sap-wood, and gradually girdling the tree? Is the root plant-louse clustering on the roots? Each of these, and many others that may be cited, are secret or inconspicuous operations, which must be sought for, with a knowledge of what they are, if you would discover them in time for their arrest.

In addition to names, the characteristics of hidden attack, habits, and the different stages of life, should be known. A shriveled head of grain or discolored stalk may indicate the presence of the wheat-midge larvæ in the head, the joint-worm knotting or twisting the stalk, the Hessian fly concealed within the sheath near a joint, or the wheat-stem maggot burrowing the stalk; or the wheat saw-fly may be busily at work cutting off the nearly matured heads and dropping to the ground one-tenth of the crop. If it were generally known that the eggs of the common apple-tree tent-caterpillar could easily be detected upon the leafless trees in autumn or winter, as a broad belt of eggs from a half-inch to three-fourths inch in length, encircling the small twigs near their tips; and if, with such knowledge they were then clipped off and burned, apple orchards would never again have to suffer from such defoliation as they were last year subjected to in Eastern New York and portions of the Eastern States and parts of New Jersey.

Enlist your Children in the Study. — It can easily be done. Give them a cluster of eggs, of which to watch the hatching, the emergence of the young caterpillars, the rapidity and eagerness with which they devour the fresh food daily brought them, the most interesting operation of shedding their skins four times (usually) during their growth, the construction of their cocoons when they have attained maturity, or their wonderful transformation to the chrysalis stage in the butterflies, and the final emergence from the pupa to the perfect-winged insect. Let them see all this, and they are made of strange material if they do not become entomologists for all future time. It will be a pleasure for them to collect insects and to study their varied and interesting habits, and to prepare collections which will adorn your homes. If consisting largely of the more injurious forms properly labelled and displayed, they would prove highly valuable for the use and instruction of your farmers' clubs, illustrating far better than figures can, the descriptions that your libraries may contain. As a guide and an aid to the children's studies put in their hands a little volume recently published by Dr. Packard, entitled, "Entomology for Beginners," in which they may find directions for collecting, preserving, and rearing insects, besides much other matter which will be of value to them and to yourselves, under the headings of "insects injurious and beneficial to agriculture;" "insect architecture;" "the structure, growth and metamorphoses, and classification of insects," etc., etc. Not only will the study be a delight to them, but it will serve, if properly pursued, as a means of mental discipline fully equal to many of the disciplinary studies of the schools. It will also place them in possession of knowledge which will better fit them to meet the demands that will be made upon the agriculturist of the future.

Procure and Study Recent Entomological Publications.— Economic entomology, has within the last few years made rapid and great advance. We, in the United States have been compelled to study insect ravages — greater here than in any other part of the world, and, as the consequence, the literature of applied entomology is far superior to that of any other country. The investigations having been made largely through appropriations from the general government or individual States, the publications have been distributed gratuitously, at the request usually of those for whose benefit they were made. If every application can not be met, it is probably owing to the fact that the demand hitherto has not been sufficiently large to warrant larger editions. There is assuredly one publication which should be procurable by every farmer who will ask for it, viz.: The valuable illustrated report of the Entomologist of the United States Department of Agriculture, Professor C. V. Riley. Of this report, contained in the annual report of the Commissioner of Agriculture, 425,000 copies are ordered by Congress, each year, but it is feared a large proportion of these never leave Washington, except as entering into the composition of other paper. The Department has also issued two reports of the United States Entomological Commission, seven bulletins of the same Commission, and eighteen bulletins of the Entomological Division. It is also issuing, at the present time through the Division of Entomology, an interesting and instructive periodical, under the name of "Insect Life." Some of the above may be still procurable through application to the Commissioner, or to Professor Riley, or to your Representatives in Congress.

The reports of Dr. Fitch, published in the Transactions of the New York State Agricultural Society, for the years 1854 to 1870, are of special value. Six of these reports, bound in two volumes, may still be obtained of the Secretary of the Agricultural Society, at Albany.

The reports of the State Entomologists of Missouri and of Illinois are also very desirable. For these, application with inquiry might be made to Professor Riley, at Washington, and to Professor S. A. Forbes, at Champaign, Illinois.

A volume that would seem to be indispensable to the fruit-grower, is "Insects Injurious to Fruits," by W. Saunders, published in 1883,* by the J. B. Lippincott Company, Philadelphia, Pa., 436 pages, 440 figures. A recent publication of particular value to the student as an aid to classification, and prepared specially for the agricultural student, is "An Introduction to Entomology," by J. H. Comstock, Professor of Entomology in Cornell University, Ithaca, N. Y. The first part only of this (price two dollars) has been published. Application for it should be made to the author.

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* A second edition has since been published.

Learn of Insecticides and how to Use them.—The publications above named, and notably those of the department at Washington, will give the needed information in this direction. The recent advance in economic entomology has been largely through discoveries of insecticides, and the invention of apparatus for their easy application. Of our best insecticides in use at the present are white hellebore, Paris green. London purple, pyrethrum, kerosene, and tobacco. It is essential that one should know how, when, and in what proportions these are to be applied, the proper dilution of those that require it, and the method of emulsifying kerosene. It is also important that the relative value of wet and dry mixtures and the most economical and effective method of application should also be known. The great practical value of a reliable insecticide was years ago taught us in the discovery of the method of destroying the Colorado potato beetle, which threatened at first to arrest potato culture in our country. More recently its value has again been clearly demonstrated in the use of the arsenites (Paris green and London purple), sprayed upon the forming fruit of our apple trees for protection from the apple-worm of the codling-moth. There is no longer question but that, by a proper use of either of the above named arsenites, at least three-fourths of the apple crop can be saved from the codling-moth. Worm-eaten apples should henceforth be a discredit and a disgrace to the fruit-grower, and each worm-hole a stamp attesting to his ignorance or inexcusable neglect.

For the judicious use of insecticides, it is important that recognition should be made of two classes of insects — those that take their food by means of biting jaws, and those that feed only on the sap of plants through a proboscis inserted in the bark. The former, which includes the larger proportion of insects, can be readily poisoned by the application of the arsenites to the foliage which they consume. The latter, consisting of the Hemiptera, such as the plant-lice (Aphides), bark-lice, and all bugs properly so-called, which imbibe their liquid food from beyond reach of the poison, are vulnerable to applications which may reach them externally, as tobacco solutions, alkaline washes, and kerosene,— the last-named closing their breathing pores and producing suffocation

Beneficial Insects should be Protected.— There are entire families of insects which consist almost wholly of species that are of direct benefit to the agriculturist, which should be known and spared from indiscriminate destruction. Of these are the *Coccinellidæ*, or lady-bugs, which have as their mission, the prevention of an overwhelming multiplication of plant-lice; the *Ichneumonidæ*, or ichneumon flies, which deposit their eggs within or upon the body of other insects, to hatch into larvæ which feed upon and destroy their host; the *Chalciddiæ* or chalcid flies which have the habits of the ichneumon flies; the *Tach nidæ*, resembling our common house-flies, also of similar habits with the last two named, and several other families which could be mentioned.

The importance of these parasitic insects will be conceded when we state that it is highly probable that to parasitic attack we owe the almost entire cessation of the ravages of the wheat-midge in the United States, when all human means seemed hopeless. At the present time, fruit culture in California, and more particularly the orange culture, is most seriously impaired, through the operation of a scale insect, known scientifically as *Icerya Purchasi* Maskell, which was introduced in the year 1868 on an acacia from Australia. It has continued to increase and spread and feed on all the fruits and much other vegetation, until its arrest, by any known application, seemed impossible. In this emergency, two agents of the United States Department of Agriculture have been dispatched to Australia, to collect the parasites that prey upon the *Icerya* there and send them to California, that an attempt may be made to colonize and multiply them. Consignments of parasites have already been received, are being propagated with care, and the present outlook is quite encouraging.

Be Careful Observers of Insects.— You have opportunities for their observation which are not accorded to those in other pursuits of life. When you have become familiar with the appearance of those which are your annual visitants, you will readily detect the advent of an unfamiliar new form. Capture it, and send it with all the information that you can obtain of its habits, to some entomologist, whose pleasure and duty it will be to tell you what it is; and if it should prove to be a new pest, he may also be able to give the directions best calculated to arrest its further spread and multiplication.

CONCLUSION.

Now that I have told you of your insect enemies—of their immense number, rapid propagation, incredible voracity, the enormous losses that they cause, and increasing injuries annually; and have also told you how you may best meet them, it may be proper to ask, "what do you propose to do in the matter ?" Does the struggle that their control will require of you seem too formidable — almost a hopeless task? Do you propose to give up to the insect all that his insatiate greed and often excessive wastefulness demands, trusting that he may leave behind him enough for your wants? Will you rest on the promise that "seed time and harvest shall not cease?" Faith is well, but "without works it is dead." Continue then to pray with fervor, as often as you join in the Church's solemn Litany, "We beseech thee, good Lord, to give and preserve to our use the kindly fruits of the earth, that in due time we may enjoy them," but do not fail to supplement your prayer with the force-pump and London purple. It was a wise saying, if construed aright, that "Providence is ever on the side of the heaviest artillery." Fight the insect as you never have before, and do not sound an inglorious retreat or yield a pitiable surrender, just as the instruments of warfare and the insecticidal ammunition, with which you may wage effectual fight, have been placed within your reach. At least show the spirit of one who came to my office to learn of me how he might successfully fight the striped cucumber beetle which had troubled him greatly. "Not that I care so much about the cucumbers," said he, "but it hurts me terribly to let that little yellow-striped cuss get the better of me." Study and perseverance will bring its recompense. It will yield you a rich return in more productive crops with less expenditure of labor. I venture to say that it will often give the desired factor for the solution of that great problem which is before you, "how to make the farm pay?" Let the myriad insect hosts feed unmolested upon your choicest products, for it is ever those that they prefer, and there is failure. Fight them energetically, scientifically, and manfully, and there is success, and a brighter future for you and your children. Do not, I beg of you, tolerate for a day longer, that inexcusable, shameful, costly neglect of the study of insect lives and insect habits.

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LIST OF PUBLICATIONS OF THE ENTOMOLOGIST.

The following is a list of the principal publications of the Entomologist during the year 1891 — fifty-six in number — giving title, place, and time of publication, and a summary of contents. A similar list of publications for the years 1875, 1876, and 1877 is appended.

The Squash Bug.* (Country Gentleman, for January 8, 1891, lvi, p. 23, c. 1, 2 — 26 cm.)

To inquiry from Kane county, Ill., answer is made that Paris green is not available against the squash-bug or any other of the bugs proper (Hemiptera). The best remedies are trapping the bugs and destroying the eggs. Trap with pieces of wood and kill the bugs found under them. Examine for egg-clusters on the underside of the leaves, and for the colonies of the newly-hatched bugs near them, and crush them. Prevent injury to the base of the stalk by applying a mixture of salt and ashes.

[Published in pp. 205–207 of this Report (viii).]

Grain Weevil Infesting Mills. (Country Gentleman, for January 15, 1891, lvi, p. 47, c. 1, 2 — 25 cm.)

For destroying weevil infesting a flour and feed store in Orange county, N. Y., which is probably *Calandra granaria* [no examples are sent], bisulphide of carbon is recommended, to be used after the manner reported by Professor Cook as having been successfully used for the purpose in a mill in Michigan. Its use in the vineyards of France against the Phylloxera, cited.

Protection from Insect Injuries. (Albany Morning Express, for January 23, 1891, p. 2, c. 5 — 28 cm.) Abstract of an Address before the Farmers' Institute at Albany, on January 22d, 1891.

Embraces the following topics: Loss from insect injuries, and their steady increase: the few insect pests known fifty years ago: the increase resulting from introduction from abroad, change of food-plants from wild to cultivated crops: importance of the study: what is being done for it by the General Government and the States: recent advance in economic entomology in the United States: our methods adopted in Europe and Australia. Means of protection are these: high cultivation, clean culture, encourage the natural enemies of insects, discriminate between beneficial and noxious insects, protect the birds, learn of insecticides and how to use them, study insect lives and habits, and read entomological publications.

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* The capitalization, etc., of the *Country Gentleman* is followed herein in the citation from it of titles of publication.

Bacon Beetle. (Country Gentleman, for February 12, 1891, lvi, p. 130, c. 3 — 6 cm.)

Dermestes lardarius infesting soiled clothing, in Ridgefield, Conn., is identified, with notice of its food, and reference to publications on it.

Insectivorous Birds. (Albany Evening Journal, for February 14, 1891, p. 6, c. 3 — 30 cm.)

Protecting the Birds. (New York Times, February 15, 1891.)

Remarks before the Assembly Committee of Game Laws, asking for such amendments and additions to the Revised Game Law as shall protect such birds as are beneficial to the agriculturist in the destruction of insect pests, and withholding protection from those which are detrimental: prominent among these last is the English sparrow.

[In MS. of Ninth Report.]

Scale Insects. (Country Gentleman, for March 26, 1891, lvi, p. 257, c. 2, 3 — 15 cm.)

Leaves of Oleander and Camellia, from Jacksonville, Ala., with supposed fungus, show attack of scale-insects — the former of *Aspidiotus nerii* Bouché, and the latter of a species of *? Parlatoria.* The general features of the two are given. When occurring on trees, they may be killed by spraying with kerosene emulsion or whale-oil soap solution. Infested plants may be treated with sweet oil, or kerosene lightly applied to the underside of the leaves with a sponge or piece of flannel.

[See in pp. 214, 215 of this Report (viii).]

Bark Lice. (Country Gentleman, for March 26, 1891, lvi, p. 257, c. 3 — 5 cm.)

To inquiry from Meadville, Pa., of an insect resembling an oat-hull in size and appearance, infesting apple trees; and also, if spraying with coal-oil in winter will kill bark-lice, — reply is made: a strong kerosene or coal-oil emulsion will kill the lice if the scales are saturated, but the emulsion can be more effectually applied at the time of the hatching of the eggs. The infesting insect can not be named from the statement made.

[A Blind Crustacean from a Well.] (Albany Evening Journal, for March 27, 1891, p. 6, c. 2 — 13 cm.; New York Times, for March 28, 1891, p. 2, c. 5—8cm.)

A small crustacean, sent from Oswego county, N. Y., as infesting a driven well of moderate depth, is identified as *Crangonyx mucronatus* Forbes — a blind species, occurring only in subterranean waters, and first discovered in a well at Normal, Illinois. It is found at the West, sometimes abundantly, in springs after heavy rains but does not live long in surface waters. This is its first recorded observation east of Indiana. Its presence in wells is not harmful, but rather beneficial, as tending to the purification of the water.

[Extended in MS. of Ninth Report.]

Injurious Insects. (Country Gentleman, for April 2, 1891, lvi, p. 273, c. 2, 3—43 cm.)

Abstract of a paper read at the New Paltz Farmers' Institute, treating of—the recent increase of insect pests; the increase largely in fruit insects; the principal depredators on the several fruits; generalization of methods for the destruction of sucking insects and biting insects; the best insecticides, viz., Paris green, London purple, and kerosene emulsion; their history, etc.; three recent triumphs in economical entomology; the benefits of arsenical spraying; fungicides combined with insecticides; reported bad results from London purple; strength of insecticides adapted to different fruits; lime lessens injury from the arsenites; the force pump; cost of spraying; several other means of protection from insect pests named.

Quince-Tree Borer. (Country Gentleman, for April 9, 1891, lvi, p. 294, c. 4—6 cm.)

To an inquiry for a remedy or preventive against this insect, a wash prepared as follows is recommended: A gallon of common soft soap and a pint of crude carbolic acid, thinned with a gallon of hot water, to stand over night or until it is perfectly united, and then eight or ten gallons of cold, soft water to be added.

Honey-Dew on Pear Twigs. (Country Gentleman, for April 16, 1891, lvi, p. 317, c. 1—16 cm.)

Pear twigs sent from Athens, N. Y., as infested with "honey-dew," are covered with a black substance, thought by some fruit-growers to be connected, or identical with, the apple scab. It is doubtless honey-dew, blackened by age and the association with it of the usual fungus that occurs on honey-dew infested foliage—a harmless form. The honey-dew could not have been deposited so abundantly by any known pear aphis. Probably the trees had been attacked by *Psylla pyri*. Search will be made for this insect during the following month.

Arsenic and Honey — Experiments. [Is Arsenical Spraying Harmful to Honey-bees?] (Country Gentleman, for April 16, 1891, lvi, p. 317, c. 1, 2 — 24 cm.)

Replying to inquiries: It has not been shown that honey bees have been killed or their honey poisoned by arsenically sprayed blossoms, although so asserted by Professor A. J. Cook and other apiarists. That such a result may follow is not believed by some of our best botanists. The question should be set at rest by proper experimentation: until then, caution should be exercised. If safe, it would be advantageous to spray during blossoming, for at this time the larvæ of some leaf-rollers could be reached, and not later.

Bulletins relating to spraying may, in many cases, be obtained by addressing the Directors of the Agricultural Experiment Stations. Director Atwater's "Experiment Station Record" is commended as useful to fruit-growers. Several of the most desirable Bulletins upon spraying, spraying apparatus and insecticides are named, and Station Directors' addresses given.

Entomology. (Proceedings of the 37th Annual Meeting of the Western New York Horticultural Society, January 28 and 29, 1891. April, 1891, pp. 10–17. Also, as Separates 8 pp.)

Report of the Society's Committee on Entomology, upon "Spraying with Insecticides," and "Some Garden and Orchard Insects." Topics embraced are the following: Effect of London purple on the plum: London purple on the peach: Solubility of London purple: An efficient nozzle for low spraying: Addition of lime to the arsenites: Fungicides combined with the arsenites: Spraying for the plum curculio: Spraying for the codling-moth: A new insecticidal machine: Insecticides lately recommended: Protection from the striped cucumber beetle: The apple curculio: The pear-blight beetle: The rose-bug: The Marguerite fly: The bean-weevil.

How to Control the Hop Aphis. (New England Homestead, for May 2, 1891, xxv, p. 193, c. 1 — 37 cm.)

In reply to editorial request for best methods of controlling the pest, the following points are noticed: The insect in Europe and America: Its life-history discovered: When to attack the aphis: How to kill the aphis with kerosene emulsion or with English wash: Repeat spraying as often as necessary: Preventive of aphis attack.

[See in pp. 207–210 of this Report (viii).]

Apple-Tree Insects of Early Spring. (Country Gentleman, for May 7, 1891, lvi, p. 374–5, c. 3, 4, 1 — 59 cm.)

Frequency of insect attacks this season, on unfolding buds, noticed. Insects received from Lansing, N. Y., are the apple aphis, *Aphis mali* Fabr., and the apple-tree case-bearer, *Coleophora malivorella* Riley. For the aphis, spray with the soap solution, tobacco water, or kerosene emulsion. The life-history of the case-bearer is given: its remedy is arsenical spraying, at times directed. Larvæ of the eye-spotted bud-moth, *Tmetocera ocellana* (Schiff.), associated with the above.

From Malcolm, N. Y., the bud-moth larvæ and the apple-leaf Bucculatrix, *Bucculatrix pomifoliella* Clemens, were sent: the best methods for destroying them are given. Operations against them should have been commenced earlier in the season.

From Lincoln, N. Y., are sent the bud-moth and its larvæ; also the pear-tree Psylla, *Psylla pyri* Schmidb., the presence of which is indicated by honey-dew; usually occurs on the pear; its apparent increase in our orchards; how to destroy it; its relationship to the *Aphididæ*.

[See in pp. 216–220 of this Report (viii).]

Orange Leaf Trouble. (Country Gentleman, for May 7, 1891, lvi, p. 375, c. 2, 3 — 11 cm.)

Spotted and blotched leaves received from Eustis, Florida, and reported as dropping from the tree, show no fungus attack or insect presence. The discoloration is not the orange-rust, caused by *Typhlodromus oleivorus*, but may possibly be owing to an attack of the trees by species of *Lecanium* or

Ceroplastes. the honey-dew from which may have been the cause of the soot-like blotches on the leaves. For such an attack, spraying with kerosene emulsion would be the proper remedy.

How to Kill the Rose-Bug. (New England Homestead, for May 9, 1891, xxv, p. 205, c. 1—33 cm.)

In the sandy soil of New Jersey, this beetle breeds in incredible numbers, and can not be controlled. In New England and New York it is within control: 1st, by beating into pans of water and kerosene; 2d, by spraying with kerosene emulsion. "1 part of oil to 9 of water"; 3d, on the authority of Professor J. B. Smith, by spraying with sludge-oil soap solution.

In New Jersey the beetle must be fought by the discovery and destruction of its breeding grounds.

[See in pp. 200–202 of this Report (viii).]

[The Cermatia Centipede.] (Albany Morning Express, for May 19, 1891, xlv, p. 8, c. 1—9 cm.)

In reply to an inquiry made, *Cermatia forceps* is identified as the household pest for which a remedy is asked. It is a Southern centipede which has extended northward and is abundant in Albany. Although poisonous, it will not be necessary to destroy it unless it should become very abundant. It subsists on small living creatures, and is fond of flies, and has secured a reputation as a "cockroach killer." It may be killed by scattering pyrethrum powder in its haunts.

The Apple-worm. (Country Gentleman, for May 28, 1891, lvi, p. 438, c. 2—12 cm.)

It is asked if it is necessary to spray for the apple-worm in a locality where there were no apples the last year. The failure of the apple crop in 1890 doubtless reduced the number of the codling-moth, and thorough arsenical spraying the present year might tend to lessen its injuries for years to come. The apple-worm is not dependent on the apple, but matures also in pears, plums, peaches, and apricots. It has been represented as breeding in walnuts in Europe, but this is probably an erroneous identification of the insect.

Wheat Insects. (Country Gentleman, for May 28, 1891, lvi, p. 438, c. 3—6 cm.)

Name is asked of an insect on wheat, from McGhee, Tenn. The smooth-headed variety only is infested, and not the bearded, in the same field. It is found also on scattered rye-heads. No insects were found in the heads when received, they having escaped. The species is probably the grain aphis, *Siphonophora avenæ* (Fabr.), although it also attacks bearded wheat, and has a seeming preference for rye.

Wire-worms in Corn. (Country Gentleman, for May 28, 1891, lvi, p. 431, c. 4—21 cm.)

From Gaysville, Vt., request is made for a remedy for worms piercing and destroying the kernels of corn. They are probably wire-worms. Salt, suggested by the inquirer, would prevent cut-worm attack, but not wire-worms. The best preventive in infested fields is starving out by crops of buckwheat or pease. A good preventive is, preparing the seed corn with soft soap and plaster according to directions given; this method has been very successful. Soaking the seed corn in kerosene for twenty-four hours before planting might be tried.

Destructive to Pears. A Pest Discovered in a Catskill Orchard. (Albany Evening Journal, for May 30, 1891, p. 8, c. 1—17 cm.)

The Diplosis pyrivora. (The Sun [New York], June 1, 1891, p. 3, c. 5 — 9 cm.)

An insect destroying almost the entire crop of Lawrence pears and attacking other varieties is discovered in the Catskill orchards. It is an European insect, first observed in this country at Meriden, Conn., in 1881. This is its second known locality in the United States. Its life-history is given. Can not be reached by the ordinary insecticides. The danger apprehended from its spread. Picking the infested fruit and burning it, recommended.

Insect Pests. (Oswego Daily Times, for June 2, 1891, vol. 49, p. 4, c. 2 — 12 cm.)

Contains notice of a new case-worm or Coleophora feeding on apple leaves; the eye-spotted bud-worm, *Tmetocera ocellana*; the cocoons of the apple-tree Buccalatrix, *B. pomifoliella*; and of *Aspidisca splendoriferella* in its case; together with remedies for the several pests.

Another Formidable Insect Pest. (Oswego Daily Times, for June 3, 1891, vol. 49, p. 5, c. 2, 3 — 50 cm.)

The pear-midge, *Diplosis pyrivora*, discovered at Catskill, N. Y., hitherto known only at Meriden, Conn., where it was introduced about 1880. Infests the Lawrence pear and other species named; how it affects the fruit; not within reach of insecticides; its life-history; importance of its control; recommendation to pick and burn the infested fruit; other methods that may be effective against it; amount of injury done.

Melon and Strawberry Pests. (Country Gentleman, for June 4, 1891, lvi, p. 457, c. 2, 3 — 18 cm.)

A request from Wellham's Crossroads, Md., for a remedy for "lice" destroying melons and cucumbers, is answered by recommending the application of kerosene emulsion, pyrethrum in powder or in water, or strong tobacco water — the insect probably being *Aphis cucumeris* Forbes. The Vermorel nozzle would best apply the spray to the aphids on the underside of the leaves. Collecting and burning the dead leaves in autumn would doubtless destroy many of the eggs of the aphis.

The insect injuring strawberry plants by puncturing the stems [no specimens sent] is probably the flea-like negro-bug, *Corimelæna pulicaria* Germ. It is difficult of control from its large number of food-plants. The applications recommended for the aphis would probably kill it.

[See in pp. 212–214 of this Report (viii).]

The Peach-Tree Borer. (Country Gentleman, for June 4, 1891, lvi, p. 457, c. 3, 4—66 cm.)

In reply to inquiries made from Waynesville, Ohio. different methods of dealing with the insect are named and given at length, of which are, cutting out the larvæ, applying wood-ashes and water in a funnel-shaped cavity around the base of the tree, the carbolic acid wash of Mr. Bateham, the carbolic acid and Paris green wash of Mr. Hale, the Shaker peach-tree borer wash, and mounding about the base of the tree. A new "tree-protector," made of wire gauze and soon to be offered in market, is described and commended. How to "head in" peach trees to promote their health.

[See in pages 181–186 of this Report (viii).]

A Serious Danger—The New Pest that Threatens the Pear Crop. (New England Homestead, for June 13, 1891. xxv, p. 249, c. 4—24 cm.)

Introduction and injuries at Meriden, Conn., of the pear-midge, and efforts there for its extermination: its description, and its renaming and illustration by Dr. Riley; its distribution in Catskill, its habits, and manner of leaving the fruit: the varieties of pears that it is known to infest; its occurrence at Catskill may be through a new importation from France.

The Gartered Plume Moth. (Country Gentleman, for June 18, 1891, lvi, p. 497, c. 3—26 cm.)

An insect sent from [Scarsdale] Westchester Co., N. Y., as webbing the terminal leaves of the grapevine, is the one above named, in its larval stage. The moth is described, its distribution stated, and for the prevention of its multiplication, crushing it by hand in its shelter is recommended. Reference to figures and to detailed descriptions.

[A New Onion Pest.] (Albany Evening Journal, for June 19, 1891, p. 8, c. 5.)

Caterpillars sent from Canastota, N. Y., as devastating the onion fields in that vicinity, are not identical with those that appeared in Orange county, N. Y., in 1885, but an allied species, viz., *Agrotis ypsilon* (Rott.), or the black cut-worm—a common and wide-spread species but not previously reported on onions. Recommendations of means for its destruction are given.

New Strawberry Pest. (Country Gentleman, for June 25, 1891, lvi, p. 575, c. 2, 3—12 cm.)

A beetle from Clifton, New Brunswick, injuring leaves and blossoms of the strawberry, is identified as *Serica tristis* LeConte, not previously reported on this food-plant. Its general appearance is described, with probabilities of its larval habits.

Lady Bug and Cherry Aphis. (Country Gentleman, for July 2, 1891, lvii, p. 537, c. 1, 2—19 cm.)

Insects received from Pittsburg, Pa., with inquiry, are the black cherry aphis, *Myzus cerasi*, which is being preyed upon by the 15-spotted lady-bird, *Anatis 15-punctata*. All of the latter are brown-black or entirely black, without their usual spots, probably as the result of their larvæ having fed on the black aphides. Other food of the insect is mentioned. A number of larvæ of Syrphus flies were also feeding on the aphides.

Beet Insects. (Country Gentleman, for July 16, 1891, lvi, p. 577, c. 4 — 30 cm.)

The serious injury to beets reported from Monroe Co., N. Y., so far as can be seen from plants sent, are not chargeable on any one insect. The plants show injury from a plant-bug — perhaps *Lygus pratensis*; from apparently some species of flea-beetles; and from some leaf-miner, which is probably a species of *Anthomyia*. Remedy for the above may be found in the use early and at the proper time, of kerosene emulsion. Reference to a valuable paper on Beet Insects.

[In MS. of Ninth Report.]

Apple Aphis. (Country Gentleman, for July 16, 1891, lvi, p. 578, c. 1, 2 — 11 cm.)

A severe attack of *Aphis mali* Fabr., recognized on apple-twigs received from Sargeantville, N. J. The injury will probably soon cease, as the insect will resort ere long to some other food-plant. Effective remedies for early in the season, are tobacco-water, soap solution, and kerosene emulsion.

The Pear-Tree Psylla. (Country Gentleman, for August 6, 1891, lvi, p. 637, c. 2, 3 — 41 cm.)

When and where *Psylla pyricola* was first observed in New York: new feature in its life-history: known formerly as *Psylla pyri*: notice of injuries from it: its present distribution in the State: the honey-dew excreted: the pupæ and pupal cases: the insect may be destroyed in its different stages, by kerosene emulsion spraying: flight of the winged insects.

Insects Injuring Red Raspberries. (Rural New Yorker, for August 8, 1891, l, p. 577, c. 3 — 13 cm.)

Caterpillar found on red raspberry at New Haven, Conn., is *Synchlora rubivoraria* (Riley). Its peculiar appearance is described and habit given of covering itself with bits of the blossoms for concealment. Its transformations, and the moth produced.

[Extended in this Report (viii), pages 129-133, as *Synchlora glaucaria*.]

Pine Beetle Injuring Linen. (Country Gentleman, for August 27, 1891, lvi, p. 700, c. 1 — 20 cm.)

Inquiry is made from Freyburg, Me., of an insect that had burrowed the pine shelving of a linen closet built the preceding year, riddling the boards with small round holes and extending upward through piles of linen on the shelves.

The insect, doubtless a burrowing beetle, can not be named from the brief account of its operations, unaccompanied with specimens of the insect. [It may be one of the *Ptinidæ*, the larvæ of which are small, and often with wood-boring habits.]

Foes of the Kilmarnock Willow. (Orange County Farmer, for September 3, 1891, x, p. 1, c. 2 — 6 cm.)

A scale-insect reported as blighting the Kilmarnock willows at Port Jervis, N. Y., is identified as the apple-tree bark-louse, *Mytilaspis pomorum* Bouché. Remedies recommended are spraying with kerosene emulsion at any time, or with a soap solution or tobacco water at the time of egg-hatching.

The New Dairy Pest. (Oswego Semi-Weekly Times, for September 4, 1891, ii, p. 1, c. 1 — 52 cm.)

Occurs in Oswego county, and how introduced: what the fly is: its present distribution in the State: its injuries to cattle: when most troublesome: how its increase may be prevented, and how it may be repelled from cattle.

[See in pp. 192–194 of this Report (viii).]

The Cow-Horn Fly in New York. (Country Gentleman, for September 10, 1891, lvi, p. 735, c. 2, 3 — 41 cm.)

Reference to its appearance and injuries in other States and notice of its occurrence in New York last year, and in Oswego and Steuben counties the present year. Efforts should be made to arrest its spread, and how it may be done. Reference to the literature of the insect.

[See in pp. 195–197 of this Report (viii).]

Leaf-Eating Beetle. (Country Gentleman, for September 10 1891, lvi, p. 735, c. 3 — 5 cm.)

A beetle taken on a cherry tree at Little Falls, N. Y., is *Euphoria fulgida* (Fabr.) — a beautiful insect, allied in habits to the May-bug. It is common in the Western States, but rather rare in the State of New York.

Elm-Leaf Beetle. (Country Gentleman, for September 10, 1891, lvi, p. 735, c. 3 — 6 cm.)

Larvæ sent from Red Bank, N. J., do not permit positive identification, but are probably those of *Galeruca xanthomelæna*. The remedy for it is spraying with London purple.

Grape Curculio. (Country Gentleman, for September 10, 1891, lvi, p. 735, c. 3, 4 — 16 cm.)

Grapes ruined by the puncture of some insect, at Sanford, Tenn., are infested by the larvæ of the grape curculio, *Craponius inæqualis* Say. The appearance of the injured grape is described, and also the larva and the beetle. Preventives recommended are bagging the grapes, jarring off the beetle in June, and working the ground to destroy the immature insect.

[In MS. of Ninth Report.]

Measuring Worm. (Country Gentleman, for September 10, 1891, lvi, p. 735, c. 4 — 8 cm.)

A caterpillar sent for name, from Green Grove, Pa., had spun up in a cocoon when received, and can not therefore be named. Its appearance, as described by the inquirer, would refer it to the *Ennominæ* among the *Geometridæ*, and possibly, from a partial view of the pupa, to *Eutrapela transversata*.

Rat-tail Larva. (Country Gentleman, for September 10, 1891, lvi, p. 735, c. 4 — 11 cm.)

A rat-tail larva, from Macedon, N. Y., is one of the *Syrphidæ*, but can not be definitely named. It resembles *Helophilus latifrons*. Feeding-habits of some of the larvæ of some of the genera, and of the flies.

The Locust Mite. (Country Gentleman, for September 24, 1891, lvi, p. 775, c. 1 — 11 cm.)

The locust mite, *Trombidium locustarum* Riley is named, and its life-history briefly given, in reply to a request for the information from Adena, Ohio, of "the parasite that deposits its small red eggs near the base of grasshoppers' wings."

[See pages 179, 180 of this Report (viii).]

The Cecropia Caterpillar. (Country Gentleman, for September 24, 1891, lvi, p. 777, c. 2, 3 — 25 cm.)

A request to describe "the wonderful adornment" of a Cecropia caterpillar sent is answered by giving the varied colorational features of its spines and tubercles, to which is added — remarks upon the beauty to be seen in the insect world, in some of the larvæ particularly, which is usually overlooked.

An Interesting Caterpillar. (Country Gentleman, for October 1, 1891, lvi, p. 797, c. 3, 4 — 12 cm.)

A long white flattened cocoon attached to a piece of apple-bark, received from Gordensville, Pa., is apparently that of a Cerura caterpillar. Striking features of these caterpillars, are, the rich colors that adorn them, and the two long, slender, reversible filaments in which the body terminates.

[The moth emerging Sept. 29th, proved to be *Artace punctistriga* Walker.]

Grapevine Leaf-Hopper. (Country Gentleman, for October 8, 1891, lvi, p. 815, c. 2, 3 — 11 cm.

Leaf-hoppers infesting grapevine leaves in Kingston, Pa., are the vine-destroying leaf-hopper, *Erythroneura vitifex* Fitch. It is compared with *E. vitis*, and its injuries stated. It may be destroyed by driving it on kerosene-saturated cloths, or by spraying the larvæ with kerosene emulsion. Burning the refuse material of the vineyard is beneficial.

[Extraordinary Flight of Moths.] (Albany Evening Journal, for October 20, 1891, c. 5 — 10 cm.)

A flight of insects, found, from specimens submitted, to be *Zerene catenaria* (Drury), is reported from Medford, Pa., as occurring during the last week in September, and continuing for two nights and a day. Reference is made to a similar flight of the same species, observed at Lackawaxen, Pa., some years ago, early in October, and to large numbers on windows in

Albany, drawn to lights within, late in September. No satisfactory cause can be assigned for such assemblies of this moth. In butterflies, as in *Danais Archippus*, it is not rare.

The Squash Bug. (Country Gentleman, for October 22, 1891, lvi, p. 854, c. 4 — 11 cm.)

Anasa tristis (De Geer), pupa and imago, is identified in examples from Lowell, Mass., and a brief sketch of its habits and transformations given. It matures in September and October, and then passes eight months in its winter retreat.

A Destructive Potato Aphis. (Country Gentleman, for October 22, 1891, lvi, p. 857, c. 4 — 20 cm.)

Aphides reported from Hamburg and Kingston, Pa., as having destroyed hundreds of acres of potatoes, and injured cabbages, on the bottom lands of the Susquehanna River, can not be identified from the poor, wingless examples sent. They are not referable to any of the four species known to feed on the potato. The range of its occurrence, so far as observed, is given.

White Grubs. (Country Gentleman, for October 29, 1891, lvi, p. 875, c. 4 — 13 cm.)

White grubs sent for name from Red Bank, N. J., may be those of *Lachnosterna fusca* (Fröhl.): but it is impossible to identify positively any of the twenty-five or more species that belong to the *fusca* group. Writings of Dr. Horn and of Professor Smith on these species quoted.

[See in pp. 174, 175 of this Report (viii).]

Sprayed Grapes are Harmless. (Entomological News, for November, 1891, ii, p. 181 — 6 cm.)

Quotes an item given to the Associated Press, in which the recent seizure and destruction in the New York market, under the direction of the Board of Health, of grapes that had been sprayed with Bordeaux mixture for the prevention of fungus attacks, is pronounced unjustifiable and rendering the officers liable to prosecution for damages. There was not a poisonous amount of copper on the grapes seized, and the little observed on the stems could readily have been removed by a bath of water and vinegar.

The Pear Midge, Diplosis pyrivora in New York. (Canadian Entomologist, for November, 1891, xxiii, p. 224.)

Noticed for the first time in New York the present year, at Catskill, N. Y.: number of the larvæ in a single pear: habits of the larvæ: proposition to destroy the larvæ by blighting the blossoms.

On the Eye-Spotted Bud Moth in Western New York. (Canadian Entomologist, for November, 1891, xxiii, p. 231.)

Abundance of *Tmetocera ocellana*: habits of the caterpillar: difficulty of reaching the larva with insecticides: does it hibernate only as a larva? methods that may be available for its destruction.

On Some of our Orgyias. (Canadian Entomologist for November, 1891, xxiii, p. 232.)

Does *Orgyia definata* occur at Albany, N. Y., as it has been stated to do? Is *O. nova* identical with *O. antiqua* of Europe?

*Do Spiders Protect Fruit-trees from Aphides? (Green's Fruit Grower, April, 1887, p. 17 — 11 cm.)

Replying to the above question:— no record appears of spiders feeding on aphides under natural conditions, while in captivity, as stated in the communication, they undoubtedly would eat them. Aphides in fruit trees are devoured by lady-bugs and larvæ of lace-wing flies before they would be found by spiders where the latter do not ordinarily occur.

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* Omitted from its proper place.

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PUBLICATIONS OF THE ENTOMOLOGIST FOR 1875-1877.

Record of Collections of New York Heterocera for the year 1873. (Twenty-seventh Annual Report of the N. Y. State Museum of Natural History, 1875, pp. 144–148.)

Contains one hundred and thirty-five species, with localities and dates of capture.

The New Apple Worm. (Albany Evening Times, for April 12, 1875, xix, p. 2, cols. 3, 4. Thirtieth Report on the N. Y. State Museum of Natural History, 1878, pp. 117–121, with additional matter, pp. 121–126. The same in Entomological Contributions, No. IV, June, 1878, pp. 5–14.)*

This entozoan, received from Middletown, N. Y., coiled in the heart of an apple, was referred to *Gordius:* what *Gordius* is and usual mode of occurrence: subsequently identified as *Mermis*, perhaps *albicans*, and probably parasitic on *Carpocapsa pomonella:* how it may parasitize the caterpillar: is its occurrence in the apple dangerous? *M. acuminata* found by Professor Comstock in an apple: *Mermis* found by Professor Riley parasitic on the apple-worm: Dr. Leidy on *Mermis acuminata* and descriptions: Leidy on other entozoa: Dr. Speyer on *Gordiaceæ* in Insects: Dr. Packard on *Gordius* and *Mermis.*

A New Apple Worm. (Country Gentleman, for April 29, 1875, xl, pp. 262, 263, cols. 4, 1 — 31 cm.)

Mermis sp., a Parasite on *Carpocapsa pomonella*, found in an apple from Orange Co., N. Y.

[Extracted from the Times article, see notice above.]

Insect on the Cabbage. (Country Gentleman, for June 24, 1875, xl, p. 392, c. 1, 2 — 13 cm.)

Identification of *Murgantia histrionica* (Hahn.), from Charlotteville, Va., together with its habits and remedies for its ravages.

[See *First Report on the Insects of New York*, 1882, pp. 264–271, fig. 77.]

Blister Beetles. (Country Gentleman, for July 1, 1875, xl, p. 407, c. 1, 2 — 23 cm.)

An insect sent from Hastings, Minn., as destructive to potato leaves is identified as the black-rat blister beetle, *Lytta murina* LeConte. It is occasionally injurious to potatoes, but is seldom very destructive. The habits of the larva are unknown.

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* Entitled, On Mermis acuminata Leidy — a Parasite on the Larva of Carpocapsa pomonella.

[Now known as *Macrobasis unicolor* (Kirby).]

Cocoons on Oats. (Country Gentleman, for July 8, 1875, xl, p. 424, c. 2 — 7 cm.)

The cocoons are of some parasite which has destroyed the larva in which the eggs were deposited, as narrated. The species is not determinable from the examples received.

Worm on Wheat. (Country Gentleman, for July 15, 1875, xl, p. 440, c. 2 — 9 cm.)

The caterpillar is that of *Leucania Harveyi*, one of the Noctuid moths which at times proves destructive to the heads of wheat in New York, Pennsylvania, etc.

[Now known as *Leucania albilinea* Hübner.]

Insects on Potatoes. (Country Gentleman, for July 22, 1875, xl, p. 472, c. 2—8 cm.)

The insects, sent from Ashfield, Mass., as sucking the juices from potato leaves, causing them to die, are *Lygus lineolaris*, one of the Hemiptera. It is almost or quite impossible to prevent their attack by external applications to the leaves as they live only on the juices of the plant.

[Now known as *Lygus pratensis* (Linn.).]

On Lycæna neglecta Edw. (Canadian Entomologist, vii, July, 1875, pp. 122, 123.)

Reasons for differing from Mr. W. H. Edwards in his belief of the identity of *L. neglecta* with *L. Lucia*, based on observations made at Center, N. Y.

[Mr. Edwards has since shown (*Papilio*, iii, 1883, pp. 85–97) that *neglecta* and *Lucia* are summer and winter forms of the polymorphic *Lycæna pseudargiolus* Boisd.-Lec.]

On Orthosia ralla Gr.-Rob. (Canadian Entomologist, for July, 1875, vii, pp. 128, 129.)

Orthosia ralla is not identical with *O. ferruginoides*, as has been stated; the points of difference given. Synonymical dicta often at fault; tendency to refer distinct species to "dimorphic forms" on insufficient grounds.

Carpocapsa Deshaiziana in Seed-vessels of Euphorbia. Read before the Albany Institute October 5, 1875. (The Argus [Albany, N. Y.], for October 11, 1875. Proceedings of the Albany Institute, ii, 1878, pp. 264–267.)

Jumping seeds exhibited, from the Alamas mountains in Sonora, contain the larvæ of *Carpocapsa Deshaiziana*, whose springing within the seeds causes their jumps. Reference to writings on it by Lucas and Professor Westwood. Three other species of jumping seeds noticed. The "jumps" described. The insect hard to mature. The leaps of the cheese-maggot and spring-beetles. Observations on a species of Podura occurring in immense numbers at Center, N. Y.

[The jumping-seed insect is now known as *Carpocapsa saltitans* Westwood. See an account of it in the *Fifth Report on the Insects of New York*, pp. 151–154. Fig. 63.]

Cucullia lætifica *Lintner* (*n.s.*). (Check-list of the Noctuidæ of America, North of Mexico, by A. R. Grote, I, November, 1875, pp. 24, 25.)

The species is described from a specimen from Bastrop, Texas, in the collection of Mr. O. Meske.

List of Catocalas occurring in the State of New York. (Twenty-seventh Annual Report of the New York State Museum of Natural History, 1875, pp. 137–140.)

Contains forty-three species, with references and synonyms.

List of New Species of New York Lepidoptera published in 1873. (Twenty-seventh Annual Report of the New York State Museum of Natural History, 1875, pp. 141–143.)

Contains eighty species, mainly by A. R. Grote, in the *Noctuidæ* and *Deltoidæ* — [the latter family united with the former by recent writers].

On Catocala pretiosa n. sp. (Canadian Entomologist, for July, 1876, viii, pp. 121, 122.)

The species is described from examples taken, at sugar, at Schenectady, N. Y. It is compared with *C. polygama*, to which it is closely allied.

Destructive Caterpillar. (Country Gentleman, for August 10, 1876, xli, p. 504, c. 2, 3 — 11 cm.)

A caterpillar which is eating the leaves of apple trees in a young orchard, at Manlius, N. Y., is, judging from the description given, *Notodonta* [*Œdemasia*] *concinna* (Sm.-Abb.).

Cabbage-eating Insect. (Country Gentleman, for September 7, 1876, xli, p. 565, c. 3, 4—14 cm.)

Strachia [*Murgantia*] *histrionica* (Hahn.) is identified as depredating on cabbages at Nashville, Tenn.: its distribution, its eggs, and its broods described.

The Grape-seed Fly. (Country Gentleman, for September 21, 1876, xli, p. 599, c. 1, 2—40 cm.)

Isosoma vitis Saunders is the insect infesting grapes received from New Jersey. Its operations are described and remedies for its attack given.

The New Carpet-bug Pest — Anthrenus scrophulariæ. [Read before the Albany Institute, October 17, 1876.] (The Albany Argus, for October 21, 1876. The [Schenectady, N. Y.] Daily

Union, for October 21, 1876. The Buffalo Courier, for October 29, 1876. Proceedings of the Albany Institute, 1878, ii, pp. 313–315.)

The injuries caused by a "carpet-bug" have been reported by newspapers for the two past years. It was observed in Schenectady, in July of 1876, the perfect insect (a beetle) reared from the larvæ, and identified as an introduced European species, *Anthrenus scrophulariæ* (Linn.). It feeds on other woolens besides carpets. Importance of efforts to arrest its spread. Other introduced European pests mentioned.

Insects in Flour. (Country Gentleman, for October 26, 1876, xli, p. 683, c. 3, 4—23 cm.)

Wheat flour, received from Robin's Nest, Ill., was swarming with a mite which was probably *Tyroglyphus farinæ* DeGeer [=*T. siro.* (Linn.)]. Its resemblance noted to *T. sacchari*, the mite that so frequently infests brown sugar. Its probable source in this instance. As the mite would be killed in baking, its moderate presence is not objectionable.

[Published in the *Fifth Report on the Insects of New York*, 1889, pp. 294, 295.]

Scale Insects. (Country Gentleman, for February 1, 1877, xlii, p. 69, c. 2, 3 — 40 cm.)

Injury caused to pear and apple trees, in Newburgh, N. Y., by *Aspidiotus Harrisii* Walsh [*Chionaspis furfurus* (Fitch)] and *Aspidiotus conchiformis* Gmel. [*Mytilaspis pomorum* Bouché]. Their appearance, natural history, and means of destruction.

Bark-lice. (Country Gentleman, for March 8, 1877, xlii, p. 151, c. 4—18 cm.)

Notice of Harris' bark louse and description of the oyster-shell bark-louse. The latter is double-brooded in the Southern States.

Apple-Tree Insects. (Country Gentleman, for April 12, 1877, xlii, p. 235, c. 4—13 cm.)

Oviposition in short double rows in twigs of a tree, are not identified, but are those of some tree-hopper. The oviposition of the white flower-cricket, *Œcanthus niveus* Harris, identified, with remarks on the appearance and habits of the cricket.

Insects of 1876 — I. (Country Gentleman, for May 31, 1877, xlii, p. 347, c. 2, 3—60 cm.)

Scarcity of the army-worm, *Leucania unipuncta* Haworth, in New York during the year. Unequal distribution of the Colorado potato-beetle throughout the State of New York, apprehensions of its introduction into Europe and preventive measures employed against it. Detection of the grape-seed fly, *Isosoma vitis*, near New York city, with description of the insect, its transformations, and remedies available against it.

Insects of 1876 — II. The New Carpet Bug. (Country Gentleman, for June 7, 1877, xlii, p. 363, c. 2, 3 — 51 cm.)

Notice of the first detection of *Anthrenus scrophulariæ* in New York, its history in the United States, its increase and ravages and remedies for it. Also, notice of a "New Potato Insect" the work of which was observed in potatoes in New York city in burrows through the tubers.

Insect on Peach Trees. (Country Gentleman, for June 7, 1877, xlii, p. 363, c. 3—12 cm.)

A caterpillar infesting the twigs of peach trees in Annapolis, Maryland, apparently a Tortricid, can not be identified from the poor material sent.

A Parasitic Insect. (Country Gentleman, for July 12, 1877, xlii, p. 448, c. 2—18 cm.)

Insects sent from Cecil Co., Md., are the larvæ of one of the *Reduviidæ*, probably *Prionotus cristatus* (Linn.). The species shows cannibalistic propensities when deprived of its usual food.

The Gooseberry Fruit Worm. (Country Gentleman, for July 12, 1877, xlii, p. 448, c. 2, 3—17 cm.)

Larvæ infesting gooseberries in Delhi, N. Y., causing them to drop to the ground, are apparently those of *Pempelia grossulariæ* Packard [*Zophodia grossulariæ* (Pack.)]: when the insect was first noticed and described; its transformations, and remedies for the attack.

Tree-Hoppers. (Country Gentleman, for July 19, 1877, xlii, p. 463, c. 4—10 cm.)

Bark from an apple-tree in Sabrevois, Province of Quebec, shows scars resulting from the egg-deposit of one of the tree-hoppers [probably *Ceresa bubalus*].

An Eastern Grasshopper. (Country Gentleman, for July 26, 1877, xlii, p. 475, c. 4—25 cm.)

Caloptenus [*Melanoplus*] *femur-rubrum* (De Geer) is very destructive to meadows in Virginia. Its habits are given. These insects are erroneously called "grasshoppers"— they are true locusts.

Blistering Beetles. (Country Gentleman, for July 26, 1877, xlii, p. 476, c. 2, 3 — 13 cm.)

Epicauta cinerea (Foerst.) and *Lytta* [*Cantharis*] *Nuttalli* Say, are destructive to potatoes and beans in Minnesota; their vesicatory properties and their distribution.

On a New Species of Cossus. (Canadian Entomologist, for July, 1877, ix, pp. 129, 130.)

The pupal cases of this insect were discovered five years ago, projecting from poplars, *Populus tremuloides*, at Center, N. Y., and the moth was taken in July of the present year. The moth is described as *Cossus Centerensis*.

The Carpet Bug. (Country Gentleman, for August 2, 1877, xlii, p. 491, c. 2–4 — 61 cm.)

In reply to inquiries from Utica, N. Y., the insect is described in its three stages: the fondness of the beetle for windows noticed; remedies suggested; may be drawn to flowers for its capture; localities where observed.

Grapevine Hog-Caterpillar. (Country Gentleman, for September 6, 1877, xlii, p. 579, c. 3 — 24 cm.)

The caterpillar of *Darapsa Myron* (Cramer), described; its habit of biting off clusters of grapes; liability to being parasitized by a *Microgaster;* habits and transformation of the parasite; the importance of knowing our insect friends.

A Pernicious Corn Insect — The Indian Cetonia. (Country Gentleman, for September 13, 1887, xlii, p. 585, c. 3, 4 — 8 cm.)

Description of the beetle found in Essex Co., Mass., eating into ears of green corn, as *Cetonia Inda* [*Euphoria Inda* (Linn.)]. It is also injurious to fruit, and has been unusually abundant the present year.

Aphis in Wheat. (Country Gentleman, for December 6, 1877, xlii, p. 779, c. 2 — 10 cm.)

An aphis infesting the stalks of young wheat below the surface of the ground in Kittanning, Pa., during the latter part of November, can not be identified with *Aphis avenæ*, as it differs from that in antennal structure.

Pea Weevil. (Country Gentleman, for December 6, 1877, xlii, p. 780, c. 2 — 7 cm.)

A weevil infesting the Southern black-fallow pea at Bruckner's Station, Va., is the *Bruchus scutellaris* Fabr. It was originally described as an European species, but is now widely distributed throughout the world. [Extended in the *Sixth Report on the Insects of New York*, 1890, pp. 31–33 (=127–129).]

(D)

CONTRIBUTIONS TO THE DEPARTMENT.

The following are the Contributions that have been made to the Department during the year 1891:

Hymenoptera.

Cells of a wasp in a fold of paper. From Rev. H. U. Swinnerton, Cherry Valley, N. Y.

Currant twigs containing the eggs of the currant-twig girdler, June 6th. From J. F. Rose, South Byron, N. Y.

A saw-fly larva on snow-berry from S. C. Bradt, Albany, N. Y.

Trichogramma sp., eighteen examples in alcohol; bred from an egg on pine. From Harison G. Dyar, Yosemite Valley, Cal.

Lepidoptera.

Larva of *Ceratomia Amyntor* Hübn., September 14th. From Mrs. Abram Lansing, Albany, N. Y.

Alypia octomaculata (Fabr.). From Mrs. Frederick Carman, Albany, N. Y.

Thirty examples of larvæ of Lepidoptera in alcohol; also alcohol examples in other stages; collected in the Yosemite Valley, Cal., as follows:

Papilio Rutulus Boisd. 1.
Phyciodes Mylitta Edw. 5.
Vanessa Antiopa Linn. 2.
Heterochroa Californica Butler, 2.
Orgyia cana H. Edw. 4 and eggs.
Orgyia definata Packard, 2; also eggs and female moth.
Orgyia leucostigma (Sm.-Abb.) 4 young.
Packardia elegans Packard.
Datana major Gr.-Rob., larva, 1 pupa.
Nadata Behrensii H. Edw. 2.
Clisiocampa constricta Stretch. 1.
Pheosia dimidiata Her.-Sch. 3.
Amphipyra pyramidoides Guen. 1.
Examples Nos. 248, 269, 274, 275, 284, 298, undetermined and unenumerated.
From H. G. Dyar, New York.

Eggs of *Halisidota caryæ* Fitch, on apple leaf. From J. G. Linsley, Oswego, N. Y.

Larvæ of *Agrotis ypsilon* (Rott.) from onion plants, June 16th. From P. F. Milmoe, Canastota, N. Y.

Zerene catenaria Cramer, from a large flight of the moths. From A. P. Case, Vernon, N. Y.

Tortricid pupal case projecting from a humming-bird's nest. From E. N. Holly, Tribes Hill, N. Y.

Larvæ of *Phoxopteris nubeculana* (Clem.), within folded apple leaves, October 10th. From John S. Wright, Palmyra, N. Y.

Larvæ of the bud-moth, *Tmetocera ocellana* (Schiff.), feeding in apple buds and leaves, April 27th to May 11th. From Malcom Little, Malcom, Seneca Co., N. Y.; from Dwight Stone, Lansing, Oswego Co., N. Y.; from Frank Mothrop, Lincoln, Wayne Co., N. Y.; from T. G. Yeomans, Walworth, Wayne Co., N. Y., also the moth.

Mature larvæ of the apple-worm, *Carpocapsa pomonella* (Linn.), from calyx end of apples November 6th. From Miss S. A. Little, Malcom, N. Y.

Larvæ and cocoons on birch of *Bucculatrix Canadensisella* Chamb. From Mrs. H. D. Graves, Ausable Forks, N. Y.

Coleophora malivorella Riley, in its hibernating case, April 27th. From Dwight Stone, Lansing, Oswego Co., N. Y. The same, May 19th, from T. G. Yeomans & Sons, Walworth, Wayne Co., N. Y.

Coleophora sp. undetermined, on apple leaves. From Dwight Stone, Lansing, N. Y., May 27th. The same from T. G. Yeomans & Sons, Walworth, N. Y. The same from Julius G. Linsley, Oswego, N. Y., June 14th.

Larvæ of *Oxyptilus periscelidactylus* (Fitch), among tips of grapevine. From D. J. Garth, Scarsdale, N. Y.

Diptera.

Larvæ of *Diplosis pyrivora* Riley, in pears, May 27th. From Theodore A. Cole, Catskill, N. Y.

Exechia sp. (one of the *Mycetophilidæ*), attracted to light. From Abner L. Train, Albany, N. Y.

A Syrphid larva resembling *Helophilus latifrons*. From J. B. Briggs, Macedon, N. Y.

Hystricia abrupta Weid. (=*Tachina vivida* of Harris). From W. H. Warrall, Wappingers Falls, N. Y.

The cow-horn fly, *Hæmatobia serrata* Rob. Desv. August 29th. From M. E. Drake, Demster, Oswego county, N. Y.

Pollenia rudis (Fabr.), as infesting a dwelling-house in April. From Anna B. Hill, Catskill, N. Y.

Chloropisca prolifica Ost. Sack. From Mrs. H. D. Graves, Ausable Forks, N. Y.

COLEOPTERA.

Larva of *Dytiscus marginalis* (Linn.), June 1st. From W. C. HITCHCOCK, Tiashoke, N. Y.

Dytiscus fasciventris Say; September 14th. From W. DUDLEY DEWITT, Albany, N. Y.

Helophilus triangularis Say. From J. M. DOLPH, Port Jervis, N. Y.

Anatis 15-*punctata* (Oliv.), dark variety from *Myzus cerasi*, June 4th. From JOHN R. & A. MURDOCK, Plattsburgh, N. Y.

Epilachna borealis (Fabr.). From GEORGE T. LYMAN, Bellport, N. Y.

Byturus unicolor Say, feeding on raspberry leaves and buds, May 25th. From Mrs. J. M. COOPER, North Haven, Conn.

Larvæ (luminous) of *Photuris Pennsylvanica* (De Geer), October 2d. From HENRY C. LEE, Cornwall, N. Y.

A brilliantly luminous ? larva of *Phengodes* sp., July 21st. From Miss C. L. STILLMAN, Cornwall, N. Y.

Larvæ of *Telephorus bilineatus* Say, taken from the surface of snow, by Mr. Holdredge, of Center, Herkimer county, N. Y. From DANIEL BATCHELOR, Utica, N. Y.

Serica tristis LeConte, from leaves and blossoms of strawberry. From R. W. WETMORE, Clifton, New Brunswick.

Young larvæ of *Ligyrus relictus* (Say). From W. S. LITTLE, Rochester, N. Y.

Larvæ and imago of *Lachnosterna fusca* (Fröhl.), taken from the ground December 14th — one larva with its fungus, *Cordiceps Ravenelii.* From D. B. YOUNG, Newport, N. Y.

Scarabæid cocoons, very large, taken from stems of palms from India. From Professor D. P. PENHALLOW, McGill University, Montreal, Canada.

Doryphora 10-*lineata* (Say), infested with *Uropoda Americana* Riley. From W. W. DE ANGELIS, Holland Patent, N. Y.

Gastroidea polygoni (Linn.). From BERTHOLD FERNOW, Albany, N. Y.

Larvæ of the cucumber beetle, *Diabrotica vittata* (Fabr.) in squash roots. From Professor C. H. PECK, Menands, N. Y.

Young larvæ of *Haltica chalybea* Illig. on grape. From A. M. MACY, South Livonia, N. Y.

Coptocycla aurichalcea (Fabr.). From C. B. WICKS, Albany, N. Y.

Bruchus obsoletus Say, from beans imported from Jamaica. From JAMES FLETCHER, Entomologist, etc., Ottawa, Canada.

Bruchus obsoletus Say, infesting kidney beans and ovipositing March 23d. From L. W. DYER, Jefferson, N. Y.

Bruchus rufimanus Bohem., the European bean-weevil. From Oliver E. Janson, Stroud Green, London, Eng.

Tribolium ferrugineum (Fabr.) in rice chaff from South Carolina, numerous examples. Larvæ of *Tenebrio molitor* (Fabr.) from wheat flour. From F. E. Wadhams, Albany, N. Y.

Nacerdes melanura (Linn.), from basement flooring in a dwelling-house. From Mrs. E. Pointer, Albany, N. Y.

Larvæ of the grape curculio, *Craponius inæqualis* (Say), in grapes, June 26th. From S. F. Gettys, Sanford, Tenn.

Phlœotribus liminaris (Harris) — living imago in peach tree bark, May 7th; *Xyleborus dispar* (Fabr.), in peach tree, June 15th. From George C. Snow, Penn Yan, N. Y.

Hemiptera.

Anasa tristis (De Geer), in pupa and imago, September 18th. From T. C. Barker, Lowell, Mass.

Lygus invitus (Say), puncturing and scarring young pears in June. From J. F. Rose, South Byron, N. Y.

Belostoma Americanum Leidy. From Berthold Fernow, Kingston, N. Y. The same, from Frank F. Goodwin, Albany, N. Y. The same, in four examples, taken at electric light, May 12th, from J. M. Dolph, Port Jervis, N. Y.

Larvæ of *Clastoptera pini* Fitch, on terminal tips of pine, June 1st. From Miss A. H. Woolsey, Matteawan, N. Y.

Larvæ of a spittle insect, *Clastoptera obtusa* (Say), June 22d, on linden: imago, June 25th. From D. J. Garth, Scarsdale, N. Y.

Psylla pyricola Foerst., in the larva, pupa, and imago, June 1st. From P. W. King, Athens, N. Y. The imago, from J. F. Rose, South Byron, N. Y., and from Mrs. Dorr, Glenmont, N. Y. The eggs, larvæ, and imago, from Professor C. H. Peck, Menands, N. Y.

Aphis pruni Koch, from plum trees, June 6th. From J. W. Smith, Schoharie, N. Y.; also, from Frank A. Fay, Bath, Steuben Co., N. Y.

Aphis sp., destructive to potatoes and cabbage. From Abram G. Hoyt, Bradford, Pa.

? *Chermes laricifoliæ* Fitch, on leaves of larch. From Miss A. H. Woolsey, Matteawan, N. Y.

Chionaspis furfurus (Fitch) on pear twigs. From P. W. King, Athens, N. Y.

Lecanium pyri (Sch.) with young, on pear, April 16th. From A. C. Taylor, M. D., Scriba, N. Y.

Orthoptera.

Gryllus luctuosus Serv., from Cape May, N. J. From W. B. **Marshall**, State Museum, Albany, N. Y.

The coral-winged locust, *Œdipoda phœnicoptera* Germ. From Mrs. H. D. **Graves**, Ausable Forks, N. Y.

Larvæ of *Mantis Carolina* Linn., on holly-twig. From Mrs. M. M. **Patten**, Albany, N. Y.

Ectobia Germanica Steph. From Dr. **George Lawson**, Halifax Nova Scotia.

Neuroptera.

The Hellgrammite fly, *Corydalis cornuta* (Linn.). From C. L. **Shear**, Alcove, N. Y.

Larva of the comb-horned fish-fly, *Chauliodes pectinicornis* (Linn.). From W. C. **Hitchcock**, Buskirk's Bridge, N. Y.

Miscellanea.

Argyramœba simson (Fabr.). *Chlosops* sp. *Grapta interrogationis* (Fabr.). *Agrotis herilis* Grote. *Pyralis farinalis* Linn. *Coccinella sanguinea* Linn. *Phytonomus punctatus* (Fabr.). *Tenebrio molitor* Linn. *Podisus spinosus* (Dallas). *Phymata erosa* Her.-Sch. From Mrs. E. B. **Smith**, Coeymans, N. Y.

Lepidopterous pupæ, undetermined, 4. *Camponotus*, many examples from a flight on August 27th. Larva of *Cimbex Americana* Leach. A Phryganid, six examples. From **Erastus Corning**, Jr., of Albany N. Y.; taken at Murray Bay, Province of Quebec, Canada.

Crustacea.

A blind freshwater shrimp, *Crangonyx mucronatus* Forbes, from a driven well. From W. B. **Campbell**, Garrattsville, Oswego Co., N. Y.

ERRATA.

Page 155, line 11, for "equably" read "equally."

Page 166, last line, read "partially filling the cavity."

Page 169, explanation of Fig. 73, last line, for "crura" read "crural."

Page 184, last line, for "muscles of" read "muscles on."

Page 192, Fig 125 is inverted.

Page 194, line 13, for "aboloid" read "oboloid."

Page 195, explanation of Fig. 135, last line, for "diduductor" read "diductor."

Page 196, explanation of Fig. 137, first line, after "Above" insert "and at."

Page 202, explanation of Fig. 149, first line, for "loop" read "jugum."

Page 204, explanations of Figs. 159–162, for "loop" read "jugum."

Page 205, explanation of Fig. 164, for "loop" read "jugum."

Page 206, line 1, for "general" read "genera."

Page 207, explanation of Fig. 168, for "loop" read "jugum."

Page 217, Figs. 195 and 196 are inverted.

Page 222, explanation of Fig. 214, for "downward" read "upward."

Page 279, line 20, for "513" read "13."

Page 300, last line, read "Rhynchonellidæ" and "terebratuloids."

(E)

CLASSIFIED LIST OF INSECTS NOTICED IN THIS REPORT.

HYMENOPTERA.

Thalessa lunator (*Fabr.*), the lunated long-sting.
Pemphredon concolor *Say*, a wood wasp.
Tremex columba (*Linn.*), the pigeon Tremex.
Rhyssa persuasoria (*Linn.*), an European long-sting.
Janus flaviventris *Fitch*, the currant-stem girdler.
Nematus Erichsonii *Hartig*, the larch saw-fly.

LEPIDOPTERA.

Feniseca Tarquinius (*Fabr.*), the little orange butterfly.
Sannina exitiosa (*Say*), the peach-tree borer.
Sphinx quinquemaculata *Haworth*, the five-spotted Sphinx.
Eudryas grata (*Fabr.*), the beautiful wood-nymph.
Clisiocampa Americana *Harr.*, the apple-tree tent-caterpillar.
Agrotis ypsilon (*Rott.*), the black cut-worm.
Agrotis species, cut-worms.
Gortyna nitela *Guenée*, the stalk-borer.
Scoliopteryx libatrix (*Linn.*), the scallop-wing.
Synchlora glaucaria (*Guenée*), the raspberry Geometer.
Tmetocera ocellana (*Schiff.*), the eye-spotted bud-moth.
Phoxopteris nubeculana (*Clem.*), the apple-leaf sewer.
Coleophora malivorella *Riley*, the apple-tree case-bearer.
Bucculatrix Canadensisella *Chamb.*, the Canadian Bucculatrix.
Bucculatrix pomifoliella *Clem.*, the apple-leaf Bucculatrix.

DIPTERA.

Diplosis pyrivora *Riley*, the pear midge.
Exechia sp., a fungus gnat.
Hæmatobia serrata *R. Desv.*, the cow-horn fly.
Trypeta pomonella *Walsh*, the apple maggot.

COLEOPTERA.

Epilachna borealis (*Fabr.*), the northern lady-bird.
Elateridæ species, wire-worms.
Telephorus bilineatus (*Say*), the two-lined soldier-beetle.
Macrodactylus subspinosus (*Fabr.*), the rose-bug.
Lachnosterna fusca (*Fröhl.*), the white-grub.
Cyllene pictus (*Drury*), the hickory borer.
Glycobius speciosus (*Say*), the maple-tree borer.
Crioceris asparagi (*Linn.*), the asparagus beetle.
Doryphora decemlineata (*Say*), the Colorado potato beetle.
Tenebrio molitor (*Linn.*), the meal-worm.

HEMIPTERA.

Corimelæna pulicaria *Germ.*, the flea-like negro-bug.
Anasa tristis (*De Geer*), the squash-bug.
Lygus invitus (*Say*), the contrary plant-bug.
Clastoptera obtusa *Say*, the obtuse Clastoptera.
Clastoptera pini *Fitch*, the pine Clastoptera.
Typhlocyba vitis (*Harr.*), the grape-vine leaf-hopper.
Empoa rosæ (*Harr.*), the rose-leaf hopper.
Psylla pyricola *Fœrst.*, the pear-tree Psylla.
Siphonophora avenæ (*Fabr.*), the grain aphis.
Phorodon humuli (*Schrank*), the hop-vine aphis.
Aphis mali *Fabr.*, the apple-tree aphis.
Aphis cucumeris *Forbes*, the melon aphis.
Pemphigus tessellata (*Fitch*), the alder-blight aphis.
Lecanium sp., a grape-vine scale-insect.
Aspidiotus nerii *Bouché*, the white scale.
Pulvinaria innumerabilis (*Rathv.*), the maple-tree scale-insect.

ORTHOPTERA.

Gryllus luctuosus *Serv.*, the doleful cricket.

NEUROPTERA.

Chauliodes pectinicornis (*Linn.*), the comb-horned fish-fly.
Chauliodes rastricornis *Ramb.*, the tooth-horned fish-fly.
Chauliodes serricornis *Say*, the saw-horned fish-fly.
Corydalis cornuta (*Linn.*), the horned Corydalis.

ARACHNIDA.

Trombidium locustarum *Riley*, the locust mite.

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ERRATA.

Page 108, line 11, for Plate 2 read Plate 3.
Page 109, line 4 from bottom, for 172 read 173.
Page 120, line 16, for 1875 AND 1876 read 1875–1877.
Page 165, line 16, for Plate 2 read Plate 3.
Page 178, line 9, for *Vetchii* read *Veitchii*.
Page 237, line 21, for *Carolinenis* read *Carolinensis*.
Page 237, lines 21–22, for *Agelœeus* read *Agelœus*.
Page 286, line 5, for Bouché read (Bouché).
Page 293, line 10 from bottom, for Harris read (De Geer).
Page 313, line 11, for 285 read 286.

ERRATA IN SEVENTH REPORT.

Page 201, line 10, for PHYTOOMYZA read PHYTOMYZA.
Page 250, line 4 from bottom, for ventral surface read dorsal segment.
Page 279, line 17, for (Boheman) read Boheman.
Page 320, line 5, for G. F. Pierce read G. T. Pierce.
Page 357, line 1, for (C) read (B).
Page 381, line 1, for (D) read (C).
Page 384, line 16, for Harris read (De Geer).
Page 396, line 26, for Mytelaspis read Mytilaspis.
Page 400, line 25, for Tiersche read Tierische.

REPORT

OF THE

STATE GEOLOGIST

FOR THE YEAR 1891.

REPORT.

To the Honorable the Board of Regents of the University of the State of New York:

Gentlemen:— During the past year, as in the several preceding years, the time of the State Geologist has been almost entirely devoted to the collection, preparation, systematic arrangement and and study of material for, and the preparation and publication of the Paleontology of New York. Volume VIII is now in press and the printing had progressed to more than 300 pages in February last, since which time no printing has been done. The manuscript for the completion of the volume, and that for the explanation of the plates has been ready for the printer since before that date, and nearly all of it was in hand at the time of suspension of printing. The plates for the illustration of the work are all completed.

The condition of this work, both as regards the volume in press and the preparation of the material, manuscript, drawings and lithographic plates for the succeeding portion of the work on volume VIII, part ii, will be given in detail further on.

During the past year it has been necessary to turn aside from this work to give attention to a subject of much interest and importance to our knowledge of the character, mineral and fossil contents and succession of the strata in central New York, from the horizon of the Genesee slate to the Salt group of Onondaga.

In November last the State Geologist received a letter from M. L. Townsend, Vice-president of the Livonia Salt and Mining Company, of Livonia, Livingston county, and of Broadway, New York, of which the following is a copy:

Livonia Salt and Mining Company,
Livonia, N. Y., *November* 3, 1890.

The Honorable the State Geologist, Albany, N. Y.:

Dear Sir. — We are engaged in sinking a shaft 12 by 24 feet at this place for the purpose of mining salt. The depth of the shaft will be about 1400 feet, and we have to go through from 600 to 700 feet of shale rock, and about the same thickness of lime rock, consisting of a stratum of Corniferous and also of Helderberg. Both the shale and the lime rock will contain many interesting and perhaps valuable specimens which your department may desire to obtain. If so, we will be glad to aid you in securing them, and to render you facilities for examinations of the rock formations if you wish to make them.

Respectfully yours.
(Signed.) M. L. TOWNSEND,
Vice-president.

To this letter I replied, thanking Mr. Townsend in behalf of the State for his interest in the subject and the consideration he had shown, and expressing myself very desirous of taking advantage of his kind offers. In reply to my letter I received the following:

Livonia Salt and Mining Company,
Livonia, N. Y., *November* 10, 1890.

Hon. James Hall, *State Geologist:*

Dear Sir.— Answering your inquiries of the sixth instant, I beg to state that our shaft is now down about seventy feet, and we have just entered the shale rock. We will be somewhat delayed for a few days in the erection of machinery, but in about two weeks we intend to be blasting in the rock, and to continue the work day and night. It will take about two years to complete the shaft.

Respectfully yours.
(Signed.) M. L. TOWNSEND.

I brought this subject before the secretary of the Regents, with my own advocacy of the work, but as there appeared to be no money available for such purposes nothing was done. The subject was again brought before the Regents at their annual meeting in December and the following resolution was offered by Regent Harris at the meeting of the committee on the State Museum, the same being afterwards voted unanimously by the Regents.

"That the Legislature be asked to appropriate $1,000 a year for two years to meet the expense of securing specimens and making records of the geological formation in the shaft to be sunk 2,000 feet at Livonia."

A copy of this resolution was sent by Secretary Dewey to the chairman of the committee of ways and means of the Assembly on March 10, 1891, but as the committee had already reported the supply bill no action could be taken. Subsequently a bill was introduced into the Assembly* providing for the completion of the Paleontology and the Geological Map and making provision for the work on the Livonia salt shaft, in the following terms:

"To enable the State Geologist to accept the offer of the Livonia Salt Company, to allow the State without charge to make records of the geological formation and to select specimens of value found in the salt shaft, covering 12x22 feet, which the company is now sinking to the depth of 2,000 feet, at Livonia, the sum of $2,000."

The bill after having passed the House was met by the deadlock in the Senate and failed to become a law. I then proposed to expend, for the purposes of the Livonia shaft exploitation, the money which had been apportioned from the general Museum appropriation for the geological and paleontological work of the year, which sum I was informed was about $800.

I then went to Livonia to examine the situation and facilities for the work, and after some preliminary arrangement with the manager of the work I sent for Mr. D. D. Luther, of Naples, with whom I had had previous correspondence regarding the undertaking. I made an arrangement with Mr. Luther to remain on the ground and to examine the rock as brought out of the shaft; to keep a record of the progress of the work; to note the nature of the rock passed through, its changes of character and to collect the fossils from the same, recording their relative depth from the surface, and other facts of interest or importance.

Unfortunately for the completeness of our record, the work in the shaft had already progressed to the depth of 350 feet before this arrangement had been consummated, and we have only been able to collect the data for that portion of the shaft from the materials upon the dump. However, we have ascertained that after passing through about sixty-eight feet of drift material (clay and gravel) the rock excavation was begun in the upper part of the Genesee slate, and the materials obtained from the output have been sufficient to complete the record, in a general way, to the point when the daily observations of the work began from the actual excavations in progress. The shaft has now progressed to the depth of about 750 feet, and we have full records of the strata passed through since the last week in May of the present year. Large collections of fossils have been made and twenty-eight boxes of specimens have been sent down to the State Hall. Some of these boxes have been opened and the contents examined, as noticed in the accompanying communication from Prof. Clarke. The final result will bring to the Museum collections a large amount of material from authentic horizons, and the observations made during their collection will show the vertical distribution of the species, and give us important information regarding the condition of the seabottom and the accumulation of sediments during this period.

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* Assembly bill 1441.

It has not been thought desirable to compile a section of the rocks, with notes on their contained fossils, at this time, but the accompanying list of species will give some information of interest. This work when completed, and the fossils compared with the nature and succession of the deposits, will form an interesting chapter in the geological history of the State.

LIVONIA SALT SHAFT.

Fauna of the Hamilton shales from the base of the Genesee, at 225 feet to a depth of 350 feet. Rocks soft, compact bluish shale, crumbling rapidly on exposure; with occasional very thin calcareous bands.

Abundant and characteristic.
- Phacops rana,
- Cryphaeus Boothi,
- Homalonotus Dekayi.
- Glyptodesma erectum,
- Ambocoelia umbonata,
- Lingula punctata.

Common.
- Platyostoma lineatum,
- Aviculopecten princeps,
- A. scabridus,
- Actinopteria decussata,
- Grammysia arcuata,
- Spirifer mucronatus,
- S. audaculus,
- Chonetes scitula,
- Dignomia alveata,
- Streptelasma rectum,
- Michelinia stylopora,
- Polypora multiplex,
- Stictopora incisurata.

Occasional.
- Proetus macrocephalus,
- Orthoceras nuntium,
- Tentaculites bellulus,
- Styliolina fissurella,
- Platyceras subrectum,
- P. symmetricum,
- Aviculopecten scabridus,
- A. exactus,
- Pterinopecten undosus,
- Lyriopecten orbiculatus,

Grammysia alveata,
G. bisulcata,
Palaeoneilo tenuistriata,
P. fecunda,
P. plana.
Strophodonta junia,
S. inaequistriata,
Streptorhynchus arctostriata,
Productella spinulicosta,
Spirifer Marcyi,
Atrypa spinosa,
Leiorhynchus quadricosta,
Modiomorpha concentrica,
Goniophora angulata,
Cypricardinia indenta,
Tellinopsis subemarginata,
Orthonota undulata,
O. parvula,
Microdon tenuistriata,
Prothyris lanceolatus,
Atrypa reticularis,
Athyris spiriferoides,
Spirifer sculptilis,
Tropidoleptus carinatus,
Strophodonta perplana,
Pholidops Hamiltoniæ,
Orbiculoidea media,
Lingula Delia,
L. maida,
L. ligea,
L. densa,
L. sp. nov.,
Fenestella sp ?
Glauconome carinata,
Heliophyllum Halli,
Amplexus intermittens.

Rare.

Bellerophon Leda,
Aviculopecten ornatus,
Modiomorpha macilenta,
M. concentrica,
Lunulicardium ? sp. nov.,
Cryptonella planirostra,
Terebratula Ontario,
Strophodonta concava,
Chonetes coronata,
Orthis Vanuxemi,
Orbiculoidea humilis,
O. grandis,
Goniatites uniangularis,
Leptodesma Rogersi,
Spirifer granuliferus,
Pentamerella papilionensis,
Favosites Argus,
Reptaria stolonifera,
Chaetetes fruticosus,
Dictyonema Hamiltoniæ,
Platycrinus sp

The included thin calcareous bands contain

Proetus macrocephalus,
Platyceras symmetricum,
Actinopteria decussata,
Spirifer fimbriatus,
S. granuliferus,
S. medialis,
Lichenalia vesciculata,
Stictopora incisurata.

Before commencing the shaft a boring* was made through the strata to the depth of 1,507 feet. The records of this boring are as given below:

	Feet.	Feet.
Clay, gravel and sand	56	56
Shale rock	464	520
Sand rock	10	530
Shale rock	302	832
Corniferous limestone (flint rock)	133	965
Hydraulic limestone	45	1,010

---

* The locality of the boring is about 1,000 feet distant from the shaft opening, in a northerly direction.

	Feet.	Feet.
Limestone	313½	1,323½
Shale and salt	11½	1,335
Pure salt	35	1,370
Salt and shale	8	1,378
Pure salt	15	1,395
Soft shale	116	1,507

The bottom of the shaft is now nearing the base of the Hamilton group, and we may expect within a few days that the Corniferous limestone will have been reached.

The observations made in the progress of this shaft will serve not only as a guide in other similar works to be undertaken in the salt bearing area within the State, but they will serve to prove the nature and thickness of some of the strata in Central New York, which can not so well be determined from the exposures on the natural outcrops of the formations.

Should the work in the shaft be continued and kept up at the rate which it has been going on during the past ten months, the final result may be reported before the end of 1892.

The money made available by the arrangement already mentioned proved to be only about $600 and at the time of this writing, expenses had already been incurred to more than that amount, and some other means must be devised for the continuance of the work.

In my report of last year I gave a pretty full account of the condition of the work upon the Paleontology of the State, volume VIII, pt. i, being then in press and printed to more than 250 pages. The printing was continued till February when there were in type over 300 pages and the remainder of the manuscript in hand or ready for the printer. At this point the printing ceased, ostensibly for want of means to go on with the work, the money originally appropriated having been expended, and since that time till the present writing no arrangement has been made for the continuance of the work. Had the printing gone on from February as in the preceding few months the volume would have been published in April last. It is certainly a great misfortune to the author and to the State, as well as to the entire scientific public, that the publication of this work should have been so long delayed, when the expenditure of $1,000 would have completed the volume.

In the meantime, and for a large portion of the past year the writer, with the aid of the regular assistant in Paleontology, Prof. Clarke, and a special private assistant, Mr. Schuchert, has been occupied in bringing together and preparing material in the way of collections; the general bibliography and the special discussions upon the genera for the second part of volume VIII.

As already stated, volume VIII, part i, has been put into type to over 300 pages, and will be completed in about 350 pages exclusive of index, which has been prepared as far as the printed matter has been paged.

Of the text of volume VIII, part ii, 207 manuscript pages have been prepared. This is equivalent to about 125 pages of printed matter. Nearly twice as much more will be required to complete the discussions. In addition to the manuscript prepared, about ninety pen-and-ink drawings for the text have been made to show the structure of the spirals and loops, etc., in various genera.

Volume VIII, part i, will contain forty-two lithographic plates, numbered as follows:

I. Inarticulata: I, II, III, IV, IVA, IVB, IVC, IVD, IVE, IVF, IVG, IVH, IVK.

II. Articulata: V, VA, VB, VC, VI, VIA, VII, VIIA, VIII, IX, IXA, X, XI, XIA, XIB, XIC, XII, XIII, XIV, XV, XVA, XVB, XVI, XVII, XVIIA, XVIII, XIX, XX.

With the exception of Plate XX, all have been printed, and that one lithographed and proved.

Of the plates to accompany part ii, the following have been printed: XXI, XXII, XXIII, XXIV, XXV, XXVI, XXVII, XXVIII, XXX, XXXI, XXXII, XXXIII, XXXIV, XXXV, XXXVI.

The following have been drawn on stone and proved: XXIX, XXXVII, XXXVIII, XL, XLVIII, and the following are lithographed but not yet proved: XLI, XLII, XLIII, XLIV, XLV, XLVI, XLVII.

The drawings on hand are sufficient to furnish the lithographer with four plates, and a few additional drawings will be sufficient to complete ten more. For the full illustration of the volume it will require from twenty to twenty-five plates in addition to these, and will necessitate the making of from 400 to 500 new drawings.

THE FOLLOWING IS A LIST OF PREPARATIONS OF SPIRALS, LOOPS AND HINGE-PLATES.

[Made by Prof. J. M. Clarke, for volume VIII., part ii.]

1.	Spirifer radiatus	3
2.	S. medialis	1
3.	S. Whitneyi	1
4.	S. perlamellosus	1
5.	S. Orestes	2
6.	S. subumbona	1
7.	S. Niagarensis	2
8.	S. crispus	2
9.	S. perplexus	2
10.	S. Oweni	14
11.	S. gregarius	8
12.	S. arenosus	18
13.	S. pennatus	2
14.	S. granuliferus	1
15.	Ambocœlia umbonata	10
16.	Crytina umbonata	5
17.	C. Hamiltoniæ	7
18.	Athyris spiriferoides	8
19.	A. subtilita	12
20.	A? congesta	7
21.	A. ambigua	1
22.	A. trinuclea	8
23.	A. Royssi	1
24.	A. subquadrata	5
25.	A. concentrica	1
26.	A. sp?	1
27.	A? Junia	3
28.	A. Angelica	1
29.	A. sublamellosa	2
30.	A. vittata	16
31.	Merista sp. n	4
32.	M? scalprum	1
33.	Meristella nasuta	2
34.	M? cylindrica	1
35.	M? nitida	14
36.	M? naviformis	3
37.	M. bella	3
38.	M. Haskinsi	1
39.	M. Doris?	12
40.	M. Barrisi	1
41.	M. laevis	2
42.	M. lenticularis	1
43.	M? intermedia	2
44.	Meristina Maria	15
45.	M. rectirostra	4
46.	Pentagonia unisulcata	4
47.	Charionella scitula	4
48.	Bifida lepida	5
49.	Kayseria lens	7
50.	Hindella Prinstana	1
51.	H. umbonata	3
52.	Nucleospira concinna	12
53.	N. ventricosa	2
54.	N. pisiformis	3
55.	N. elegans	1
56.	Retzia Adrieni	7
57.	R. Barrandii	1
58.	R. evax	15
59.	R? sobrina	1
60.	R? longirostris	2
61.	Rhynchospira formosa	6
62.	R. sp?	11
63.	Trematospira camura	2
64.	T? Deweyi	3
65.	T? hirsuta	7
66.	T. multistriata	4
67.	T. perforata	1
68.	Eumetria Mormoni	11
69.	E. Verneuiliana	6
70.	E. vera	8
71.	Atrypa reticularis	12
72.	A. marginalis	1
73.	A. spinosa	1
74.	A? bisulcata	4
75.	Zygospira modesta	5
76.	Z. erratica	2
77.	Z. recurvirostra	16
78.	Z. Kentuckiensis	4
79.	Z. Anticostiensis	1
80.	Cœlospira? Camilla	4
81.	C. concava	5
82.	C. acutiplicata	2
83.	C? imbricata	6
84.	Leptocœlia fimbriata	1
85.	Koninckina Leonhardi	4
86.	Rhynchonella Indianensis	1
87.	R. neglecta	2
88.	R? cuneata	2
89.	Anastrophia internascens	1
90.	Camarophoria Schlotheimi	1
91.	C? eucharis	1
92.	C. calcifera	3

93. Triplesia lateralis	4
94. Rensselæria mutabilis	3
95. R. Suessana	8
96. Terebratula sp?	4
97. T? Calvini	1
98. Cryptonella planirostra	3
99. Dielasma bovidens	2
100. Vitulina pustulosa	3
101. Tropidoleptus carinatus	1
102. Eichwaldia reticulata	2
Total	468

A LIST OF THE GENERA OF THE PALAEOZIC BRACHIOPODA,

giving citations to the printed portion of the Paleontology of New York, volume VIII, part i, to the manuscript determinations for parts i and ii, and indicating the genera to be discussed in the remainder of the work.

(Terms regarded as synonyms are in *italics* and unnumbered.)

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72. Gonambonites, Pander, 1840.
73. Polytoechia, sub-gen. nov ... 239, 240
74. Scenidium, Hall, 1860 ... 241–243
    Mystrophora, Kayser, 1871.
75. Orthidium, gen. nov ... 244
76. Strophomena, Rafinesque (de Blainville), 1825 ... 245–252
77. Orthothetes, Fischer de Waldheim, 1830 ... 253–257
78. Hipparionyx, Vanuxem, 1842 ... 257–259
79. Kayserella, gen. nov ... 259, 260
80. Derbya, Waagen, 1884 ... 260–263
81. Meekella, White and St. John, 1868 ... 264–266
82. Streptorhynchus, King, 1850 ... 267, 268
83. Triplecia, Hall, 1858 ... 269–271
    Dicraniscus, Meek, 1872.
84. Mimulus, Barrande, 1879 ... 272, 273
84. Streptis, Davidson, 1881 ... 274
86. Leptaena, Dalman, 1828 ... 276–280
    Leptagonia, McCoy, 1844.
87. Rafinesquina, gen. nov ... 281–283
88. Stropheodonta, Hall, 1852 ... 284–289
    89. Pholidostrophia, sub-gen. nov ... 287
    90. Leptostrophia, sub-gen. nov ... 287, 288
    91. Brachyprion, Shaler, 1865 ... 288
    92. Douvillina, Œhlert, 1887 ... 288, 289
93. Strophonella, Hall, 1879 ... galley proof.
    94. Amphistrophia, sub-gen, nov ... do
95. Leptella, gen. nov ... do
96. Leptænulopsis, Haupt, 1878 (??) ... do
97. Plectambonites, Pander, 1830 ... do
98. Christiania, gen. nov ... do
99. Leptænisca, Beecher, 1890 ... do
100. Davidsonia, Bouchard, 1849 ... do
101. Chonetes, Fischer de Waldheim, 1837 ... do
    102. Anoplia, sub-gen. nov ... do
103. Chonetina, Krotow, 1888 ... do
104. Chonostrophia, gen. nov ... do
105. Chonopectus, gen. nov ... do
106. Chonetella, Waagen, 1884 ... do
107. Strophalosia, King, 1844 ... do
    Leptœnalosia, King, 1845.
    Orthrothrix, Geinitz, 1847.
108. Daviesiella, Waagen, 1884 ... do
109. Aulosteges, von Helmerson, 1847 ... do

110. Productus, Sowerby, 1812	not printed.
111. Productella, Hall, 1867	do
112. Marginifera, Waagen, 1884	do
113. Proboscidella, Œhlert, 1887	do
114. Etheridgina, Œhlert, 1887	do

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115. Spirifer, Sowerby, 1815	In manuscript	subject to revision.
116. Delthyris, Dalman, 1828	do	do
Trigonotreta, Koenig, 1825	do	do
Choristites, Fischer de Waldheim, 1825	do	do
Brachythyris, McCoy, 1844	do	do
Fusella, McCoy, 1844	do	do
117. Martinia, McCoy, 1844	do	do
118. Reticularia, McCoy, 1844	do	do
119. Martiniopsis, Waagen, 1883	do	do
120. Cyrtia, Dalman, 1828	do	do
121. Spiriferina, d'Orbigny, 1847	do	do
122. Syringothyris, Winchell, 1863	do	do
123. Cyrtina, Davidson, 1858	do	do
124. Ambocœlia, Hall, 1860	do	do
125. Metaplasia, nom. propos	do	do
126. Meristina, Hall, 1867	do	do
Whitfieldia, Davidson, 1882	do	do
127. Whitfieldella, nom. propos	do	do
128. Hyatella, nom. propos	do	do
129. Merista, Suess, 1851	do	do
Camarium, Hall, 1859	do	do
130. Dicamara, nom. propos	do	do
131. Meristella, Hall, 1859	do	do
132. Charionella, Billings, 1861	do	do
133. Camarospira, nom. propos	do	do
134. Pentagonia, Cozzens, 1846	do	do
Goniocœlia, Hall, 1861	do	do
135. Athyris, McCoy, 1844	do	do
Spirigera, d'Orbigny, 1847	do	do
Euthyris, Quenstedt, 1871	do	do
136. Actinoconchus, McCoy, 1844	do	do
137. Cliothyris, King, 1850	do	do
138. Seminula, McCoy, 1844	do	do
139. Spirigerella, Waagen, 1883	do	do
141. Kayseria, Davidson, 1882	do	do
142. Bifida, Davidson, 1882	do	do
143. Nucleospira, Hall, 1859	do	do
144. Eumetria, Hall, 1864	do	do

145. Acambona, White, 1862	In manuscript	subject to revision.
146. Hustedia	do	do
147. Retzia, King, 1850	do	do
148. Trematospira, Hall, 1857	do	do
149. Parazyga, nom. propos	do	do
150. Rhynchospira, Hall, 1859	do	do
151. Homœospira, nom. propos	do	do
152. Ptychospira, nom. propos	do	do
153. Uncinella, Waagen, 1883	do	do
154. Uncites, Defrance, 1825	do	do
155. Hindella, Davidson, 1852	do	do
156. Dayia, Davidson, 1881	do	do
157. Cyclospira, nom. propos	do	do
158. Atrypa, Dalman, 1828	do	do
Spirigerina, d'Orbigny, 1847	do	do
159. Gruenewaldtia, Tschernyschew, 1885	do	do
160. Karpinskia, Tschernyschew, 1885	do	do
161. Atrypina, nom. propos	do	do
162. Zygospira, Hall, 1862	do	do
Orthonomœa, Hall, 1858	do	do
Anazyga, Davidson, 1882	do	do
163. Catazyga, nom. propos	do	do
164. Glassia, Davidson, 1882	do	do
165. Anoplotheca, Sandberger, 1856	do	do
166. Leptocœlia, Hall, 1857	do	do
167. Cœlospira, Hall, 1863	do	do
168. Rhynchonella, Fischer de Waldheim, 1809	Discussions	not yet prepared.
169. Cyclothyris, McCoy, 1844	do	do
170. Hypothyris, Phillips, 1841	do	do
171. Wilsonia, Quenstedt, 1871	do	do
172. Uncinulus, Bayle, 1878	do	do
173. Terebratuloidea, Waagen, 1883	do	do
174. Rhynchotrema, Hall, 1860	do	do
175. Rhynchopora, King, 1856	do	do
176. Rhynchoporina, Œhlert, 1887	do	do
177. Eatonia, Hall, 1857	do	do
178. Stenocisma, Conrad, 1839	do	do
179. Rhynchotreta, Hall, 1879	do	do
180. Liorhynchus, Hall, 1860	do	do
181. Pentamerus, Sowerby, 1813	do	do
182. Zdimir, Barrande, 1881	do	do
183. Sieberella, Œhlert, 1887	do	do
184. Conchidium, Linné, 1760	do	do
185. Gypidium, Dalman, 1828	do	do
186. Gypidula, Hall, 1867	do	do
187. Pentamerella, Hall, 1867	do	do
188. Camarophoria, King, 1846	do	do
189. Barrandella nom. propos	do	do

190.	Lycophoria, Lahusen, 1885	Discussions not yet prepared.	
191.	Anastrophia, Hall, 1867	do	do
192.	Brachymerus, Shaler, 1865	do	do
193.	Camarella, Billings, 1859	do	do
194.	Syntrophia, gen. nov	do	do
195.	Stricklandinia, Billings, 1863	do	do
196.	Amphigenia, Hall, 1867	do	do
197.	Clorinda, Barrande, 1879	do	do
198.	Branconia, Gagel, 1890	do	do
199.	Porambonites, Pander, 1830	do	do
200.	Isorhynchus, King, 1850	do	do
201.	Eichwaldia, Billings, 1868	do	do
202.	Dictyonella, Hall, 1867	do	do
203.	Aulacorhynchus, Dittmar, 1872	do	do
204.	Isogramma, Meek and Worthen, 1873	do	do
205.	Lyttonia, Waagen, 1883	do	do
206.	Oldhamina, Waagen, 1883	do	do
207.	Stringocephalus, Defrance, 1827	do	do
208.	Terebratula, Muller, 1776	do	do
209.	Dielasma, King, 1850	do	do
210.	Epithyris, King, 1850	do	do
211.	Waldheimia, King, 1850	do	do
212.	Cryptacanthia, White and St. John, 1868	do	do
213.	Eudesia, King, 1850	do	do
214.	Hemiptychina, Waagen, 1883	do	do
215.	Centronella, Billings, 1859	do	do
216.	Cryptonella, Hall, 1861	do	do
217.	Rensselaeria, Hall, 1859	do	do
218.	Newberria, Hall, 1891	do	do
219.	Meganteris, Suess, 1856 = (Megalanteris)	do	do
220.	Notothyris, Waagen, 1882	do	do
221.	Richthofenia, Kayser, 1883	do	do

Additions to the Palæontological Collections.

November, 1890 — September, 1891.

By Donation.

	No. specimens.
T. Rupert Jones, London, Eng.:	
Primitiæ and Ulrichiæ. Bala beds. Welshpool, Montgomeryshire	4
Bernix Tatii, Jones. Yoredale series. Walwick grange, Northumberland	2
Cypris punctata. Upper Purbeckian, Meups Bay	1
C. leguminella. Upper Cypris shales, Meups Bay	1
C. Purbeckensis. Lower Purbeckian, Ridgeway Hill	2
C. Purbeckensis. Lower Purbeckian, Worbarrow Bay	2
G. H. Mahan, Norwich, N. Y.:	
Hamilton fossils	5
G. Lindström, Stockholm, Sweden:	
Goniophyllum pyramidale, Hisinger. Gotland	7
The Assistant Palæontologist:	
Fossils from a pleistocene shell marl, Canandaigua Lake, N. Y.	
Helix albolabris, Say	15
H. thyroides, Say	15
H. Sayi, Binney	1
H. alternata, Say	13
H. tridentata, Say	20
H. fuliginosa, Griffith	2
H. appressa, Say	4
H. palliata, Say	1
H. perspectiva, Say	3
H. striatella, Anthony	2
H. labyrinthica, Say	11
H. monodon, var. fraterna	4
Hyalina lineata, Say	3

	No. specimens.
Hyalina arborea, Say	14
Hy. viridula, Say	4
Hy. fulva, Say	3
Zonites suppressa, Say	8
Cionella subcylindrica, Linné	2
Succinea ovalis, Gould	4
Pupa contracta, Say	2
P. armifera, Say	1
P. curvidens, Gould	2
Carychium exiguum, Say	2
(Identifications corrected and verified by Mr. W. B. Marshall.)	
Emmett Brown, Belfast, N. Y.:	
Retzia Eugenia, Bill. Hamilton group, York, N. Y	7
Nucleocrinus sp.? Hamilton group, York, N. Y	1
Dr. E. Holzapfel, Aachen, Germany:	
Bifida lepida. Middle Devonian, Pelm	10
W. R. Billings, Ottawa, Canada :	
Atrypa bisulcata. Trenton group, Ottawa	7
Charles Schuchert, Albany, N. Y.:	
Palæaster ? sp. Clinton group, Clinton, N. Y.	1
W. B. Marshall, Albany, N. Y.:	
Spirifer arrectus. Oriskany sandstone (boulder), New Baltimore, N. Y.	2
Platyceras sp.? Lower Helderberg limestone, New Baltimore, N. Y.	1
C. F. Goodwin, Cleveland, Ohio:	
Coal plant. Ashland, Pa.	1
Agnes Crane, Brighton, England:	
Orthis hybrida. Wenlock, Benthall Edge, Shropshire	11
O. elegantula. Wenlock, Benthall Edge, Shropshire	9
Nucleospira pisum. Wenlock, Benthall Edge, Shropshire	3
Spirifer crispus. Wenlock, Benthall Edge, Shropshire	3
Glassia obovata. Wenlock, Benthall Edge, Shropshire	2
Atrypa reticularis. Wenlock, Benthall Edge, Shropshire	5
Porambonites ? Lower Silurian, near St. Petersburg	3

	No. specimens.
Athyris ambigua. Carboniferous, Tyrone, Ireland	1
A. protea. Carboniferous, Caucasus	1
A. planosulcata. Carboniferous, Welton, Staffordshire	1
Athyris ? sp ? Locality ?	1
Terebratula sacculus. Carboniferous, Welton, Staffordshire	4
The Assistant Palæontologist :	
Lepadocrinus sp ? Lower Pentamerus limestone, Coeymans, N. Y.	1
Spirifer Vanuxemi. Tentaculite limestone, Coeymans, N. Y.	1
Leptæna rhomboidalis. Corniferous limestone, Canandaigua, N. Y.	1
Orthoceras sp. Chemung group, Jasper, N. Y.	1
Modiomorpha. Chemung group, Jasper, N. Y.	2
Total	244

BY EXCHANGE.

Dr. D. F. Lincoln, Geneva, N. Y.:	
Centronella impressa. Hamilton group, Bellona, N. Y.	6
Spirifer asper. Hamilton group, Slate Rock Falls, Geneva, N. Y.	1
S. granuliferus. Hamilton group, Slate Rock Falls, Geneva, N. Y.	1
Pharetrella tenebrosa. Marcellus shales, Slate Rock Falls, Geneva, N. Y.	1
Dinicthys Lincolni, Claypole, 1893 (type), Marcellus shales, Slate Rock Falls, Geneva, N. Y.	1
Orthis Vanuxemi. Hamilton group, Slate Rock Falls, Geneva, N. Y.	1
Lingula sp ? Corniferous limestone, near Geneva	1
A. L. Arey, Rochester, N. Y.:	
Meristina nitida. Clinton group, Rochester	35
Atrypa reticularis. Clinton group, Rochester	1
Pentamerus sp. nov. Clinton group, Rochester	1
Rhynchonella sp. Clinton group, Rochester	2
G. L. Houser, Iowa City, Iowa:	
Stromatopora. Devonian, Iowa City, Ia	2
Diphyphyllum. Devonian, Solon, Ia	1
Megistocrinus Farnsworthi. Devonian, Solon, Ia	5

	No. specimens.
Orthis Iowensis. Devonian, Iowa City, Ia	9
Atrypa reticularis. Devonian, Buffalo, Ia	5
Atrypa reticularis. Devonian, Solon, Ia	4
A. aspera. Devonian, Solon, Ia	16
Athyris vittata. Devonian, Buffalo, Ia	7
Athyris vittata. Devonian, Iowa City, Ia	14
Spirifer Parryanus. Devonian, Buffalo, Ia	3
Spirifer Parryanus. Devonian, Montpelier, Ia	8
S. pennatus. Devonian, Solon, Ia	6
Pentamerus coms. Devonian, Solon, Ia	3
Rhynchonella alta. Devonian, Solon, Ia	18
Terebratula Iowensis. Devonian, Robert's Ferry, Ia	1
Straparollus cyclostoma. Devonian, Coralville, Ia	5

Dr. Th. Tschernyschew, St. Petersburg (not before reported):

Pentamerus Bashkiricus. Devonian, Russian Urals	1
P. galeatus. Devonian, Russian Urals	3
Rhynchonella livonica. Devonian, Russian Urals	2
R. Meyendorfi, Devonian, Russian Urals	1
R. procuboides. Devonian, Russian Urals	2
R. cuboides. Devonian, Russian Urals	2
Spirifer bifidus. Devonian, Russian Urals	2
S. pachyrhynchus. Devonian, Russian Urals	2
S. Jeremejewi. Devonian, Russian Urals	3
S. elegans. Devonian, Russian Urals	2
S. Anossofi. Devonian, Russian Urals	5
Atrypa reticularis. Devonian, Russian Urals	2
A. aspera. Devonian, Russian Urals	4
A. Alinensis. Devonian, Russian Urals	2
Cyrtia Murchisoni. Devonian, Russian Urals	2
Orthis Ivanovi. Devonian, Russian Urals	1
O. striatula. Devonian, Russian Urals	1
Camarophoria subreniformis. Devonian, Russian Urals	1
Chonetes plebeia. Devonian, Russian Urals	1

Charles Schuchert, Albany, N. Y.:

Specimens from the Marcellus shales and limestone at Chapinville, Mertensia and Canandaigua, N. Y.; consisting principally of cephalopoda and plants	200
Posidonomya Becheri. Culm. Bredelar, Germany	1
P. tuberculata. Culm. Lautenthal, Germany	2

	No. specimens
Goniatites crenistriatus. Culm. Winterberg, Germany	2
Goniatites crenistriatus. Culm. Schalke, Germany	2
G. coronula. Culm. Clausthal, Germany	1
Plants. Coal measures. Pomeroy, Ohio, (slabs)	2
Platycrinus granosus. Coal measures, Tournai, Belgium	2
Ceratites nodosus. Muschelkalk. Göttingen, Germany	1
Monotis Alberti. Muschelkalk. Rüdersdorf, Germany	1
Rhynchoteuthis. Muschelkalk. Berklingen, Germany	1
Tæniodon Ewaldi. Rhætic. Elliehausen, Germany	2
Gresslya abducta. Jura. Dohnsen, Germany	5
Perna isognomoides. Jura. Dohnsen, Germany	1
Ammonites Gervillei. Jura. Dohnsen, Germany	8
A. polyplocus. Jura. Fichtelgebirge, Germany	1
Pholadomya Murchisoniana. Jura. Ollerhausen, Germany	1
P. acuticosta. Kimmeridge, Holtzen, Germany	3
Pecten. Kimmeridge, Holtzen, Germany	1
Cyprina Brongniarti. Kimmeridge, Holtzen, Germany	4
Cercomya excentrica. Kimmeridge, Holtzen, Germany	1
Exogyra virgula. Kimmeridge, Holtzen, Germany	40
Fish tooth. Kimmeridge, Holtzen, Germany	1
Exogyra arietina. Cretaceous. Mountain City, Texas	11
Catopygus fenestratus. Cretaceous, Ciply	2
Sponge spicules. Cretaceous. Vorwohle, Germany	1
Ostrea gigantea. Tertiary. Morro, Cal	2
O. Idrianensis. Tertiary. Morro, Cal	4
Pecten discus. Tertiary. Morro, Cal	1
Mytilus Inezensis. Tertiary. Morro, Cal	1
Pecten sp. Tertiary. Morro, Cal	2
P. Veatchi. Tertiary. Morro, Cal	1
Melania. Tertiary. Paris, France	1
Cypræa coccinella. Tertiary, Palermo, Italy	1
Fusus multisulcatus. Tertiary. Basle	1
Planorbis euomphalus. Tertiary. Headon Hill, England	2
Limnea longiscata. Tertiary. Headon Hill, England	2
Pectunculus Philipi. Post-tertiary, Hitzaeker, Germany	2
Clausilia similies. Post-tertiary. Zierenberg, Germany	4
Bulimus montanus. Post-tertiary. Zierenberg, Germany	3
Planorbis carinatus. Post-tertiary. Saxe-Weimar, Germany	1
Limnæa palustris. Post-tertiary. Saxe-Weimar, Germany	9
Helix incarnata. Post-tertiary. Zierenberg, Germany	5

	No. specimens.
Reptilian coprolites. Post-tertiary. Georgetown, S. Car	6
Elephant tooth. Post-tertiary. Charleston, S. Car	1
Emmett Brown. Belfast, N. Y.:	
Retzia Eugenia, Bill. Hamilton group. York, N. Y	6
Taxocrinus. Chemung group. Belfast	1
Rhynchonella cf. pugnus. Chemung group. Belfast	2
Terebratula cf. navicella. Chemung group. Belfast	10
T. sp. Chemung group. Belfast	4
Centronella Julia ?. Chemung group. Belfast	1
Athyris Angelica. Chemung group. Belfast	5
E. A. Parks, Clarence, N. Y.:	
Dalmanites aspectans. Corniferous limestone. Clarence	1
Atrypa congesta. Clinton group (drift)	1
E. H. Raymour, Kansas City, Mo.:	
Proetus crassimarginatus. Corniferous limestone. Waverly, Ind	28
P. cf. macrocephalus. Corniferous limestone. Waverly, Ind.	9
Brachiopods (various species), Corniferous limestone. Waverly, Ind	42
Gastropods. Corniferous limestone. Waverly, Ind	7
Aviculopecten sp. Corniferous limestone. Waverly, Ind	2
F. B. Loomis, Spencerport, N. Y.:	
Brachiopods. Clinton shale. Buell avenue, Rochester	200
Dr. Friedrich Schmidt, Reval. Russia:	
Eurypterus Fischeri. Rootsikull, Œsel	2
Pterygotus Osiliensis. Rootsikull, Œsel	2
Porambonites gigas. Lyckholm, Estland	1
Leptocœlia Deshayési. Estland	1
Atrypa imbricata. Estland	1
Obolus Apollinis. Tegelecht	1
Onchus Murchisoni. Œsel	1
Pentamerus borealis. Weissenfeld	3
Volborthella tenuis. Reval	1
Thyestes verrucosus. Rootsikull, Œsel	1
Pachylepis. Œsel	1
Tentaculites curvatus Beyrichia Wilckensiana } Œsel	1

	No. specimens
Olenellus Mickwitzi. Estland	1
Platyschisma helicites. Œsel	2
D. G. Anderson, Keokuk. Iowa:	
Brachiopods (various species). Keokuk limestone. Keokuk	60
L. A. Cox:	
Brachiopods (various species), Keokuk limestone. Keokuk	73
Total	1,002

By Collection.

Jacob Van Deloo, November, 1890:

Fossils from the Chazy limestone. Keeseville. N. Y. (museum ticket, 1,113)	244

D. D. Luther, May–July, 1891:

Fossils from the Genesee and upper Hamilton shales at the Livonia salt shaft, 19 boxes, 1 barrel.

Fossils, September, 1891, from the middle Hamilton shales, 9 boxes.

Martin Sheehy and Jacob Van Deloo, September, 1891:

Fossils from the Oriskany fauna, near Hudson, N. Y., 9 boxes (approximately 700 specimens).

Summary of Receipts.

By donation	244
By exchange	1,002
By collection (approximately)	2,600
Total	3,846

During the past year two school collections have been selected, labeled and sent out as follows: Parker Union School of Clarence, New York, containing 170 species and 241 examples. St. Lawrence University, Canton, St. Lawrence county. New York, 140 species and 217 examples.

I report herewith a communication from Prof. J. M. Clarke, Assistant Palæontologist, together with a List of Original and Illustrated specimens in the Palæontological collections. Part I, CRUSTACEA. It is intended to continue this work until the list shall be completed in all classes of fossils embraced in the Palæontology of New York. The preparation of such a list of each class of fossils (to be illustrated) has been a long time contemplated by the writer and it is very gratifying to be able to present at this time the first installment of the work.

The requirement to present the Annual Report in October has necessarily left unfinished several communications which would have been completed during the coming months, had the preesntation of the report been delayed till the end of the year, which has been the custom until the present occasion.

Very respectfully,

Your obedient servant.

JAMES HALL,
State Geologist.

ALBANY, *October*, 1891.

CATALOGUE

OF THE

Collection of Geological and Palæontological Specimens, Donated by the Albany Institute to the State Museum.

[Prepared by Professor John M. Clarke and communicated to Professor James Hall, State Geologist, December 1, 1891.]

CATALOGUE.

The collection of the Albany Institute was received at the State Museum in the month of August, and formally donated to the institution on the 6th of October, 1891.* When the fossils came into my hands I found them in bad condition. Such labels as existed had been gathered into piles and boxes by themselves, with the exception of the few instances in which they had been glued to the specimens. The majority of the specimens, however, bore a numeral ticket, which had been copied upon the separated labels, and by means of this arrangement the matching of the few labels with their specimens was not difficult. Fortunately, these labeled specimens constitute the most important part of the collection; they are mostly Trilobites, and embrace a number of the original types used by Dr. Jacob Green in his "Monograph of Trilobites of North America," with much other interesting material of the same class, and in addition are several type-specimens of Cephalopods from the Black River limestone, described by yourself in volume I of the Palæontology of New York.

Of this series of labeled specimens a few are evidently missing, but perhaps not as many as, under the circumstances, one might expect. It appears from the labels on the rest of the collection that the specimens were divided into groups, each with its own form of numerical ticket. It is understood that there was a manuscript register or catalogue of these specimens, but it was not found among the documents pertaining to the collection nor delivered with it, and subsequent careful search among the archives of the Institute has failed to discover it. The want of this catalogue has naturally added greatly to the task of identifying the specimens. On account of the historical value of this collection I have taken much pains to locate such material as proves to be a genuine contribution to the State Museum. By far the greater number of specimens are from familiar outcrops of the New York series of formations, and their source can be approximately indicated without much danger of error. For us the value of this collection lies almost wholly in its New York palæozoic fossils; the few mesozoic and tertiary specimens being from scattered and uncertain American and European localities.

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*The extensive collection of minerals donated to the State Museum at the same time, together with other collections of natural history, have not come under the cognizance or control of the State Geologist, and no account of them can be given in this connection.

ALBANY INSTITUTE COLLECTION. FOSSILS.

I. A small series labeled by Prof. Amos Eaton, but without localities

"1 Gorgonia ripisteria Nobis" = *Polypora celsipora*, Hall.

In a fragment of decomposed Corniferous chert, apparently from western New York.

The original description of this species is as follows:

" *G. ripisteria,* very branching and net-form, spread out like a fan; branchlets subcompressed, coalescent, minutely striated: bark granulose. Found at Bethlehem in corniferous limerock; 1½ inches long." (Geological Text Book. 2nd. Ed., p. 43, pl. 4, fig. 47, 1832.)

" 2 Coscinopora macropora "

From the Lower Helderberg shaly limestone.

" *C. macropora* (large-mouthed net-stone) patella-form, pores orbicular, interstices with greater or less punctures.

"In second graywacke on Becraft Mt., near Hudson. Very irregular in external form." (*Op. cit.* p. 43, pl. 5, figs. 59, 60.)

3 and 4 missing.

"5 Turbinolia mitrata" = a worn specimen of *Streptelasma corniculum*, Hall. Trenton limestone.

Original description:

" *T. mitrata* (mitred cone, smooth horn), subcompressed on the sides; apex incurved: lamellæ thickish, sub-connate and papillose at the surface, unequal, somewhat toothed, forming an ovate, stellate disk. My specimens average an inch in length. Found at Glens Falls." (*Op. cit.*, p. 39, pl. 3, figs. 32, 33.)

6, 7, 8 missing.

"9 Cyathophyllum ceratites." (*Cystiphyllum*) Corniferous limestone.

"10 Lithodendron dichotomum" = *Bythotrephis gracilis,* Hall. Trenton limestone.

Original description:

" *L. dichotomum* (cylindrical stone tree). Cespetose, erect. Subflexuose; branches dichotomous, densely striate; little stars excavated orbicularly. Very common at Glens Falls, lying between the layers of the limerock." (*Op. cit.*, p. 39, pl. 4, fig. 43.) The description and figures represent a true coral, which, if correct, do not apply to any of the known species from the Trenton limestone.

11 missing.

"12 Astrea stylophora"=*Michelinia stylopora* Eaton (sp.). Hamilton group.

Original description:

"*A. stylopora* (star stone). Hemispherical; little stars angle-tubular, approximating and contiguous, margin glabrous, lamellæ distant; the center of the column or star extended a little. Common on the south bank of Lake Erie; about one inch in diameter." (*Op. cit.*, p. 40, pl. 4, fig. 48.)

"13 Columnaria sulcata"=*Columnaria alveolata* (Goldfuss), Hall, Black River limestone.

Original description:

"*C. sulcata* (furrowed corals) tubes generally parallel and straight, sometimes a little curved; furrowed longitudinally and substriate; lamellæ of the stars radiating from the center, and the marginal ones alternating. Very abundant in transition limerock at Glens Falls, where it is generally dark brown. We find some there whose prismatic columns are six inches long." (*Op. cit.*, p. 41, pl. 5, fig. 51.)

"14 Columnaria alveolata"=*Favosites Helderbergiæ*, Hall, Lower Helderberg (Shaly limestone).

This is apparently Prof. Eaton's identification of Goldfuss' species. His description is:

"*C. alveolata* (coral cakes). Hemispherical (often concave, convex and sometimes flat) tubes unequal in length, striated longitudinally, and radiating from the base; those lamellæ of the little stars are rather remote which radiate from the center, the marginal ones alternating. Very abundant over the Coral cone on the Helderberg. They are from three inches in diameter to ten." (*Op. cit.*, p. 40, pl. 4, figs. 44, 45.)

"15 Sarcinula macrophthalma, var. prismatica." Label only.

16, 17, 18, 19 missing.

"20 Terebratula Perovalis." Label only.

21 missing.

"22 Terebratula spiriferoides, Nobis"=*Athyris spiriferoides*, Eaton (sp.). Hamilton group. (*Op. cit.*, p. 46.)

"23 Terebratula dimidiata" (*Pentamerella arata*, Hall). Corniferous limestone.

"24 Spirifer alternatus." Label only.

"25 Resembles Spirifer Walcottii. Probably near = *Spirifer macropleura*, Conrad." Lower Helderberg (Shaly limstone).

26 missing.

"27 A pentacrinite being the Encrinus dicyclus" = Crinoidal disks from the Hamilton or Chemung group.

"28. Encrinus transversus" = *Phytopsis tubulosa*, Hall.
Birdseye limestone.

Original description:

"*E. transversus* (birdseye pins) rings low or confluent, so that the column appears nearly or quite smooth; perforates strata transversely. Found in the lowest and most compact layers of metalliferous limerock. It is called Encrynal by Conybeare and Birdseye marble by stonecutters." (*Op. cit.*, p. 36.)

"29. Encrinus interruptus." Corniferous limestone.

"30. Productus depressus in 2d Graywacke" = *Leptæna rhomboidalis*, Wilckens. Lower Helderberg (Shaly limestone).

"31. Orthocera circularis" = *Orthoceras* sp.? probably from the Corniferous limestone. (*Op. cit.*, p. 29, pl. 3, fig. 27.)

"32 Cancer triloboides Nobis" = *Brongniartia carcinodea*, Eaton, 1832 = *Triarthrus Becki*, Green, 1832. Utica slate.

"33. Conularia quadrisulcata" = *Conocardium trigonale*, Conrad.
"Cyathophyllum ceratites" = *Zaphrentis* sp.?
"Gorgonia ripisteria" = *Polypora celsipora*, Hall (?).

II. The collection of Trilobites had been carefully labeled by the late Dr. T. R. Beck, and though these labels were all displaced, the numbering on both labels and specimens has facilitated their replacement. This collection is composed of some small lots not included in the serial numbering of the general collection, and a few embraced the initiatory portion of the latter.

1. Plaster-of-paris models of Trilobites described by Dr. Jacob Green in his "Monograph of the Trilobites of North America," 1832.

No. 1, Calymene Blumenbachii, Brongniart, Trenton Falls.
No. 2, C. callicephala, Green, "Hampshire, Virginia."
No. 5, C. platys, Green, Helderberg (3 specimens).
No. 6, C. microps, Green, near Ripley, Ohio. (?)
No. 9, C. macrophthalma, Brongniart, Leheighton, Pa.
No. 10, C. Bufo, Green, New Jersey.
No. 17, Asaphus caudatus, Brünnich, Ripley, Ohio.
No. 28, Cryptolithus tesselatus, Green, Champlain canal.
No. 31, Dipleura DeKayi, Green, Northumberland, Pa. (?)

No. 32, Trimerus delphinocephalus, Green, Williamsville, N. Y. (?)
No. 35, Nuttainia sparsa, Eaton, Coeymans, N. Y.
Also model of the original of Isotelus magnus, DeKay, Trenton Falls, N. Y.

2. *The James Eights collection:*
   1, Cryptolithus tesselatus, Green, Glens Falls, N. Y.
   2, Calymene bufo, Green, Helderberg.
   3, Triarthrus Beckii, Green, 7 miles east of Little Falls, N. Y.
   5, Asaphus (=*Dalmanites anchiops*, Green), Helderberg, N. Y.
   6, Dalmanites anchiops, Green (without label).
   8, Asaphus micrurus, Green (=*Dalmanites pleuroptyx*, Green) Helderberg, N. Y.
   9, Dipleura DeKayi, Green, Black river, Jefferson county, N. Y. (?)
   "The heads of two trilobites in the Dudley limestone," (=Phacops Downingiæ), Dudley, England.
3. *The G. W. Clinton collection:*
   (a) Dipleura DeKayi, Green (specimen mentioned in Green's Monograph, p. 80), Madison county, N. Y.
   (b) "A Fragment of the Isotelus gigas" (Gov. Clinton's label), = Dipleura DeKayi, Green (specimen mentioned in Green's Monograph, p. 80), Steuben county (?? probably Madison county) N. Y.
   (c) Dipleura DeKayi, Green (specimen mentioned in Green's Monograph, p. 80), Cazenovia, N. Y.
   (d) "Head of the Isotelus, Cazenovia, Madison county" (Gov. Clinton's label),= Dipleura DeKayi (specimen mentioned in Green's Monograph, p. 80).
   (e) Dipleura DeKayi, Green, Steuben (?? probably Madison) county, N. Y.
4. *Small miscellaneous lot:*
   "Petrified crab or cancer in 2d Greywacke," = *Triarthrus Becki*, 2 specimens.
   Dalmanites anchiops (without label). Fragment.
5. *Trilobites of the General Collection.*
   I, a, 1. Calymene anchiops, Green. ORIGINAL. Ulster county, N. Y. *John R. Bleecker, Don.*
   I, a, 2. Missing.
   I, a, 3. Calymene platys, Green. Corniferous limestone, Coeymans, N. Y.
   I, a, 4. Calymene bufo, Green. (The head.) Corniferous limestone, Bethlehem, N. Y. *T. R. Beck, Don.*

I, a, 5. Calymene Blumenbachii. ("Dudley Trilobite.") Ohio. *T. R. Beck, Don.*

I, a, 6. Calymene bufo. var. rana, Green. ORIGINAL. Seneca, Ontario county, N. Y. *M. H. Webster, Don.*

I, a 7. Dipleura DeKayi, Green. (Specimen mentioned in Green's Monograph, p. 80.) Cazenovia, N. Y. *L. C. Beck, Don.*

I, a, 8. Trimerus delphinocephalus, Green. ORIGINAL. (Also Palæontology of New York, vol. 2, pl. 68, fig. 3.) Banks of Lake Ontario, Monroe county, N. Y. *James Eights, Don.*

I, a 9. Trimerus delphinocephalus, Green. (Specimen mentioned in Green's Monograph, p. 82.) Banks of Lake Ontario, Monroe county, N. Y. *M. H. Webster, Don.*

I, a, 10. Calymene Blumenbachii, Brong. Canajoharie, N. Y. *James Eights, Don.*

I, a, 11. Asaphus micrurus, Green. Becraft's Mt., near Hudson, N. Y. *M. H. Webster, Don.*

I, a, 12. Asaphus Wetherilli, Green. ORIGINAL. Rochester, N. Y. *L. C. Beck, Don.*

I, a, 13. (*Calymene callicephala*, Green, Trenton limestone.) Label missing.

I, a, 14. Isotelus gigas, DeKay. Norway, Herkimer county, N. Y. *James Hadley, Don.*

I, a, 15. Isotelus (fragment). Trenton Falls, N. Y. *H. W. Snyder, Don.*

I, a, 16. Two worn specimens of Trilobite (*Calymene callicephala*, Green.) Trenton Falls, N. Y. *M. H. Webster, Don.*

I, a, 17. Calymene Blumenbachii. Trenton Falls, N. Y. *H. W. Bauman, Don.*

I, a, 18. (*Odontocephalus selenurus.* Corniferous limestone.) Label missing.

I, a, 19. Missing.

I, a, 20. Calymene bufo, Green. (Hamilton group. Locality missing.)

I, a, 21. Missing.

I, a, (b), 22. (*Dalmanites pleuroptyx*, Green. Lower Helderberg The Heldeberg, N. Y.)

I, a, 23. Calymene bufo. (*Phacops Logani*, Hall.) Lower Helderberg limestone. Schoharie, N. Y. *J. Gebhard, Don.*

I, a, 24. Calymene bufo. (Hamilton group. Locality missing.) *C. Delafield, Don.*

I, a, 25. (*Isotelus gigas.* Trenton limestone.) Label missing

I, a, 26. Calcareous slate with Trilobites (= *Triarthrus Becki*, Green), 7½ miles east of Little Falls, N. Y.

I, a, 27. (*Dalmanites anchiops*, Green. Schoharie grit.) Label missing.

I, a, 28. (*Dalmanites pleuroptyx*, Green. Delthyris shaly limestone.) Label missing.

I, b, 1. Isotelus. ORIGINAL (Palæontology of New York, vol. I pl. 61, fig. 3g. There identified as *Isotelus gigas*, De Kay, but probably a distinct species). Crown Point, N. Y. *John James, Don.*

I, b, 2. (*Dalmanites pleuroptyx*, Green. Lower Helderberg group. The Helderberg, N. Y.)

I, b, 3. (*Dalmanites limulurus*, Green. Niagara group, Rochester, N. Y.)

I, b, 4. Asaphus caudatus (= *Dalmanites limulurus.* Green). Specimen described in Green's Monograph, p. 56, as *A. pleuroptyx.* Genesee river, N. Y. *James Eights, Don.*

I, b, 5. (*Dalmanites micrurus*, Green. Lower Helderberg group. The Helderberg, N. Y.)

I, b, 6. Asaphus selenurus, Eaton. Corniferous limestone. Helderberg. James Eights.

I, b, 7. Missing.

I, b, 8. Ceraurus pleurexanthemus, Green. 3 specimens. ORIGINALS. Trenton limestone. Newport, N. Y. *T. R. Beck, Don.*

I (II), b, 9. (*Dalmanites micrurus*, Green. ORIGINAL. Lowe Helderberg, Schoharie county, N. Y.)

I, b, 10. Tail of Isotelus (*gigas*, De Kay). Trenton limestone. Mastigouche river, Canada. *T. R. Beck, Don.*

I, b, 11. (*Dalmanites micrurus*, Green. Lower Helderberg. The Helderberg, N. Y.)

I, b, 12. (*Dalmanites myrmecophorus*, Green. Corniferous limestone. N. Y.) Label missing. 2 specimens belonging together,

I (II), b, 13. (*Dalmanites pleuroptyx*, Green. ORIGINAL. Lower Helderberg (Shaly limestone), Albany county, N. Y.)

I, b, 14. Asaphus Hausmanni. (=*Phacops rana*, Green). Eaton. coll. Hamilton group. Western, N. Y.)

I, b, 15. Asaphus caudatus (Eaton's label). (?) Oriskany fauna, near Hudson, N, Y.

I, b, 16. Asaphus caudatus (Eaton's label). (?) Oriskany fauna, near Hudson, N. Y.

I, b, 17. Asaphus in Greywacke. South Sea Islands (?) (Probably *Dalmanites* sp. nov. Oriskany fauna, near Hudson, N. Y.) *S. De Witt Bloodgood, Don.*

I, b, 18. (*Dalmanites pleuroptyx,* Green. Lower Helderberg group. Schoharie, N. Y.)

I, b, 19. Asaphus laticostatus, Green (=*Dalmanites pleuroptyx,* Green). Schoharie, N. Y. *J. Gebhard, Don.*

I, b, 20. Asaphus selenurus, Eaton. Corniferous limestone. Schoharie, N. Y. *J. Gebhard,* Don.

I, b, 21. Calymene bufo, Green (=*Phacops cristata,* var. *pipa*). Corniferous limestone. Schoharie, N. Y. *J. Gebhard, Don.*

See I, a, (b), 22.

I, b, 23. (*Dalmanites limulurus:* Green, Lockport,? N. Y.) Label missing.

I, c. 1. Trimerus delphinocephalus. Green. Genesee River, N. Y. *James Eights, Don.*

I, c, 2. Trimerus delphinocephalus. Green. (Specimens described in Green's Monograph, p. 82.) Williamsville (? probably Lockport), N. Y. *J. Hadley, Don.*

I, d, 1. Cryptolithus tesselatus. Green. Four specimens (1 missing). Glens Falls, N. Y. *M. H. Webster, Don.*

Also, Calymene platys. Green. ORIGINAL. Helderberg Mt. Albany county, N. Y. *T. R. Beck, Don.*

Two plaster moulds of Dipleura DeKayi. Green. Cazenovia, N. Y.

6. *Balance of the General Collection.*

These specimens are virtually without other label than the catalogue ticket, and as the catalogue is missing the restoration of localities is in many cases a matter of approximation. The great majority of the specimens, however, are from the State of New York and their origin is not a matter of much uncertainty. In this list the choicer specimens, which are really important additions to the collections of the State Museum are indicated by an asterisk on the margin of the page.

*I, b, 21. *Gonioceras anceps.* Hall. Black River limestone. Watertown, N. Y.

*I, b, 7. *Murchisonia.* Lower Pentamerus limestone. Helderberg.

I, (or II), b, 19, (*Orbiculordea graudis,* Vanuvem), Oriskany sandstone. The Helderberg, N. Y.

II, b, 1. Lower Helderberg limestone. Helderberg.

II, b, 2. Lower Pentamerus limestone. Helderberg.

II, b, 3. Missing.
II, b, 4. Lower Pentamerus limestone. Helderberg.
II, b, 5. Chert. Lower Carboniferous.
II, b, 6. Clinton group. Tennessee?
II, b, 7. Crinoid columns, Clinton group.
II, b. 8. Missing.
II, b, 9. *Arthrophycus Harlani.* Medina Sandstone. Western N. Y.
*II, b. 10. *Arthrophycus Harlani.* Medina Sandstone.
II, b, 11. Crinoid columns. Chemung group. N. Y.
II, b, 12. Crinoid columns. Chemung group, N. Y.
II, b, 13. Crinoid columns. Niagara group, Wisconsin?
II, c, 1. *Cornulites. Orthis.* Hudson River Sandstone, Niskayuna, N. Y.
II, c, 2. *Cornulites. Orthis. Modiolopsis.* Hudson River Sandstone, Niskayuna, N. Y.
II, c, 3. Crinoid columns. Delthyris Shaly limestone, Berne, N. Y
II, c, 4. Crinoid columns. Corniferous limestone, Eastern N. Y.
III, 2, b, 1. *Schizodus?* Locality? Europe.
III, 2, c, 1. *Gresslya.* Locality? Europe.
III, 2, d, 1. *Cyprina.* Locality? Europe.
III, 2, d, 2. *Glycimeris.* Locality? Europe.
III, 2, g, 2. *Cyprina?* Locality? Europe.
III, 2, k, 1. "Ostracite? West. Dist." *Limoptera macroptera,* Hamilton group, Central N. Y.
III, 2, k, 2. *Limoptera macroptera.* Hamilton group, Central N. Y.
III, 2, k, 3. Missing.
III, 2, k, 4. Missing.
III, 2, k, 5. Missing.
III, 2, k, 6. *Grammysia bisulcata.* Hamilton group, Central N. Y.
III, 2, l, 1. "Pectinite, Helderberg." *Hipparionyx proximus.* Oriskany sandstone.
III, 2, l, 2. "Pectinites in Greywacke." *Spirifer mucronatus,* Conrad. Hamilton group, Rensselaerville, N. Y.
III, 2, l, 3. *Spirifer mucronatus,* Conrad. Hamilton group, Rensselaerville, N. Y.?
III, 2, l, 4. *Spirifer mucronatus,* Conrad. Hamilton group, Rensselaerville, N. Y.?
III, 2, l, 5. *Spirifer mucronatus,* Conrad. Hamilton group, Rensselaerville, N. Y.

III, 2, l, 6. "Pectinite, West. Dist." *Spirifer granulosus,* Conr. Hamilton group, Western N. Y.

III, 2, l, 7 (2 specimens). "Pectinite, Helderberg." *Spirifer arenosus,* Conr. Oriskany sandstone.

III, 2, l, 8. *Orthis testudinaria.* Trenton limestone, "from Big Sandy Creek, Jefferson county, about two miles above its mouth."

III, 2, l, 9. *Rafinesquina alternata.* Trenton limestone, Central N.Y.

III, 2, l, 10. Missing.

III, 2, l, 11. Missing.

III, 2, l, 12. Missing.

III, 2, l, 13. Missing.

III, 2, l, 14. Missing.

III, 2, l, 15. Belemnite. Locality?

III, 2, l, 16. *Cyprina?* Lias? Locality?

III, 2, l, 17. Missing.

III, 2, l, 18. *Spirifer mucronatus,* Conr. Hamilton group, Central N. Y.

III, 2, l, 19. *S. arenosus,* Conr. Oriskany sandstone, Eastern N. Y.

III, 2, l, 19. S. disjunctus, Sow. Chemung sandstone, N. Y.

III, 2, m. 1. "Anomite, Helderbergh" *Rensselœria ovoides,* Hall. Oriskany sandstone, N. Y.

III, 2, m, 2. "Anomite, Rensselaerville" *R. ovalis,* Hall. Oriskany sandstone, N. Y.

III, 2, m, 3. *Atrypa reticularis,* Linn. Corniferous limestone, N. Y.

III, 2, m, 4. Missing.

III, 2, m, 5. *Meristella bella,* Hall. Lower Helderberg group, Albany county, N. Y.

III, 2, m, 6. *Atrypa, Meristella, Proetus,* etc. Schoharie grit, Albany county, N. Y.

III, 2, m, 7. Missing.

* III, 2, m, 8. "Anomite, Rensselaerville," *Rensselœria ovalis,* Hall. Oriskany sandstone, N. Y.

* III, 2, m, 9. *Rensselœria ovoides,* Hall. Oriskany sandstone, N. Y.

III, 2, m, 10. *Rensselœria ovoides,* Hall. Oriskany sandstone, N. Y.

III, 2, m, 11. Missing.

III. 2, m, 12. "Anomites in argillite," *Liorhynchus limitaris.* Marcellus shale, N. Y.

III, 2, m, 13. "Anomites in limestone, Fairfield, Herkimer county," *Orthis testudinaria.* Trenton limestone, N. Y.

* III, 2, m, 14. *Rensselæria ovoides,* Hall. Oriskany sandstone, N. Y.

III, 2, m, 15. Missing.

* III, 2, m, 16. *Strophomena deltoidea,* Conrad. Trenton limestone, Eastern N. Y.

III, 2, m, 17. Missing.

III, 2, m, 18. *Rhynchonella.* Hamilton group, Albany county? N. Y.

III, 2, m, 19. *Strophomena deltoidea,* Conrad. Trenton limestone, Eastern N. Y.

III, 2, m, 20. *Leptæna* sp.? Trenton limestone, N. Y.

III, 2, m, 21. *Pentamerus galeatus.* Lower Helderberg group, N. Y.

III, 2, m, 22. *Rhynchonella.* Chalk flint, England.

III, 2, n, 1. Missing.

III, 2, n, 2. "Gryphite, Bethlehem," *Pentamerus galeatus.* Lower Helderberg group, N. Y.

III, 2, n, 3. "Gryphite, Helderberg," *Pentamerus galeatus.* Lower Helderberg group, N. Y.

III, 2, n, 4. "Gryphite, Helderberg," *Pentamerus galeatus.* Lower Helderberg group, N. Y.

III, 2, n, 5. "Gryphite, Helderberg," *Pentamerus galeatus.* Lower Helderberg group, N. Y.

* III, 2, o, 1. "Terebratulite, Helderbergh," *Spirifer arrectus,* Hall. Oriskany sandstone.

III, 2, o. 2. "Terebratulites, Coeymans," *Spirifer mucronatus,* Conr. Hamilton group.

III, 2, o, 3. "Terebratulites, Rensselaerville," *Tropidoleptus carinatus,* Hall. Hamilton group.

III, 2, o, 4. "Inside of a Terebratulite, Bethlehem," *Hipparionyx proximus,* Vanuxem. Oriskany Sandstone.

III, 2, o, 5. *Spirifer arrectus,* Hall. Oriskany sandstone.

III, 2, o, 6. "Terebratulite, Helderbergh," Spirifer arenosus, Hall. Oriskany sandstone.

III, 2, o, 7. "Terebratulites in Greywacke, Coeymans," *Rhynchonella.* Hamilton group, N. Y.

* III, 2, o, 8. *Spirifer arenosus,* Hall. Oriskany Sandstone, Albany county, N. Y.

III, 2, o, 9. *Hipparionyx proximus*, Vanuxem. Oriskany Sandstone, Albany county, N. Y.

* III, 2, o, 10. *Hipparionyx proximus*, Vanuxem. Oriskany Sandstone, Albany county, N. Y.

* III, 2, o, 11. *Hipparionyx proximus*, Vanuxem. **Original.** Oriskany sandstone, Albany county, N. Y.

III, 2, o, 12. Missing.

III, 2, o, 13. Missing.

III, 2, o, 14. Missing.

III, 2, o, 15. *Spirifer*. Chemung group, N. Y.

III, 2, o, 16. Missing.

III, 2, o, 17. *Zygospira erratica*, Hall, etc. Hudson River group, Central N. Y.

III, 2, p, 1. "Mytilite, West. Dist." *Grammysia arcuata*, Hall. Hamilton group, N. Y.

III, 2, p, 2. *Modiolopis modiolaris*. Hudson River group, Central N. Y.

III, 2, p, 3. *Ambonychia radiata*. "From the high grounds bordering Salmon River, two or three miles from the present shore of Lake Ontario, Oswego co."

III, 2, p, 4. *Lingula cuneata*. Medina standstone, Albion, N. Y.

III, 2, p, 5. *Actinopteria decussata*. Hall. Hamilton group, N. Y.

III, 2, p, 6. *Goniophora Hamiltonensis*. Hamilton group, N. Y.

III, 3, a, 1. *Nautilus*. Triassic, Europe.

III, 3, a, 2. *Ammonites*. Triassic, Europe.

III, 2, p, 8. *Crassatella*. Jurassic, Europe.

III, 2, p, 9. *Crassatella*. Jurassic, Europe.

III, 3, b, 1. *Ammonites*. Jura, Solenhofen?

III, 3, b, 2. *Gyroceras trivolve*. Hall. Corniferous limestone, Schoharie, N. Y.

*III, 3, b, 3. *Gyroceras trivolve* (3 specimens). Corniferous limestone, Schoharie, N. Y.

*III, 3, b, 4. *Gyroceras trivolve* (2 specimens). Corniferous limestone, Schoharie, N. Y.

III, 3, b, 5. *Ammonites*. Jurassic, England.

III, 3, b, 6. *Ammonites* (2 specimens). Jurassic, England.

III, 3, b, 7. *Ammonites*. Jurassic, England.

III, 3, b, 8. *Ammonites*. Jurassic, England.

III, 3, b, 9. *Ammonites*. Jurassic, England.

III, 3, b, 10. *Ammonites*. Jurassic, England.

*III, 3, b, 11. *Goniatites Vanuxemi.* Hall. Goniatite limestone, Schoharie, N. Y.

III, 3, b, 12. *Ammonites.* Jurassic, Europe.

III, 3, b, 13. *Ammonites.* Jurassic, Europe.

III, 3, b, 14. *Ammonites.* Jurassic, Europe.

III, 3, b, 15. *Ammonites.* Jurassic, Europe.

III, 3, b, 16. *Ammonites.* Jurassic, Europe.

III, 3, b, 17. *Ammonites.* Jurassic, Europe.

III, 3, b, 18. *Ammonites.* Jurassic, Europe.

*III, 3, b, 19. *Lituites convolvans.* Hall. ORIGINAL (Palæontology of New York, vol. 1, pl. 13, fig. 2*a*). Black River limestone, Watertown, N. Y.

*III, 3. d, 1. *Endoceras longissimum.* Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 2. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

III, 3, d, 3. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

III, 3, d, 4. *Endoceras proteiforme.* Hall. Trenton limestone, N. Y.

III, 3, d, 5. *Endoceras proteiforme.* Hall. Trenton limestone, N. Y.

III, 3, d, 6. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

III, 3, d, 7. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 8. *Endoceras.* Black River limestone, Watertown, N. Y.

*III, 3, d, 9. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 10. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 11. *Endoceras.* Black River limestone, Watertown, N. Y.

*III, 3, d, 12. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 13. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 14. *Ormoceras tenuifilum.* ORIGINAL. (Palæontology of New York, vol. I, pl. 15, figs. 1, 1*a*, 16, plate 16, fig. 1*a*). Black River limestone, Watertown, N. Y.

III, 3, d, 15. *Endoceras proteiforme*. Hall. Trenton limestone N. Y.

III, 3, d, 16. *Endoceras proteiforme*. Hall. Trenton limestone, N. Y.

*III, 3, d, 17. *Ormoceras tenuifilum*. Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 17. *Ormoceras tenuifilum*. Hall. Black River. ?North shore of Lake Huron.

*III, 3, d, 18. *Ormoceras tenuifilum*. Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 19. *Ormoceras tenuifilum*. Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 20. *Orthoceras* sp.? Hamilton group, Central N. Y.

III, 3, e, 1. Missing.

III, 3, e, 2. Missing.

III, 3, e, 3. Missing.

III, 3, e, 4. *Belemnites.* Locality ?

III, 3, e, 5. *Belemnites.* Locality ?

III, 3, e, 6. Missing.

III, 3, e, 7. " Belemnites. Pennsylvania."

III, 3, k, 1. " Buccinite Helderbergh." *Loxonema* sp.? Lower Helderberg limestone.

III, 3, n, 1. " Turbinite Helderbergh." *Platystoma* sp. ? Schoharie grit.

III. 3, n, 2. " Turbinite Helderbergh." *Platystoma* sp. ? Schoharie grit.

III, 3, n, 3. *Maclurea* sp. Chazy limestone, N. Y.

III, 3, n, 4. *Platystoma* sp. ? Coniferous limestone, N. Y.

III, 3, n, 5. *Platyceras* sp. ? Schoharie grit, N. Y.

III, 3, n, 6. *Platyceras spirale* Hall. Lower Helderberg group, N. Y.

*III, 3, n, 7. *Lituites undatus,* Hall. ORIGINAL. (Palæontology of New York, vol. I, pl. 13, pp. 1a, 1b.) Black River limestone, Watertown, N. Y.

III, 3, n, 8. *Platystoma.* Corniferous limestone, N. Y.

III, 3, n, 9. Missing.

III, 3, n, 10. *Pleurotomaria sulcomarginata,* Hall. Hamilton group, Central N. Y.

III, 3, q, 1. *Leptæna rhomboidalis.* Locality ?

III, 3, q, 2. *Leptæna rhomboidalis* var. *ventricosa,* Hall. Oriskany limestone, N. Y.

III 3, q, 3. *Leptæna rhomboidalis.* Coniferous limestone, N. Y.

III, a, a, 1. *Baculites.* Cretaceous. Locality?

III. a, 10. *Spirifer arrectus*, Hall. Oriskany sandstone. The Helderberg, N. Y.

IV, a, 1. *Halysites catenulata.* Niagara group, N. Y.

IV, a, 2. Missing.

IV, a, 3. *Eridophyllum.* Niagara group, N. Y.

IV, a, 4. *Syringopora.* Niagara group, Western N. Y.

IV, a, 5. Missing.

IV, a, 6 (2 specimens). *Columnaria alveolata.* Black River lime stone, Eastern N. Y.

IV, b, 1. *Zaphrentis.* Corniferous limestone, Helderberg.

IV, b, 2. *Zaphrentis.* Corniferous limestone, Helderberg.

IV, b, 3. *Zaphrentis.* Corniferous limestone, Helderberg.

IV, b, 4. *Zaphrentis.* Corniferous limestone, Helderberg.

IV, b, 5. *Zaphrentis.* Corniferous limestone, Helderberg.

IV, b, 6. *Zaphrentis.* Corniferous limestone, Helderberg.

IV, b, 7. *Zaphrentis.* Corniferous limestone, Helderberg.

IV, b, 8. *Zaphrentis.* Corniferous limestone, Helderberg.

IV, b, 9. *Heliophyllum.* Corniferous limestone, Helderberg.

IV, b, 10. *Atrypa reticularis.* Corniferous limestone, Helderberg.

IV, b, 11. "Inside of a Cornua-Madreporite, Bethlehem." *Zaphrentis.* Schoharie Grit, N. Y.

IV, b, 12. *Heliophyllum.* Corniferous limestone, N. Y.

IV, b, 13. *Streptelasma rectum*, Hall. Hamilton group, Lake Erie.

IV, b, 14. *Heliophyllum.* Corniferous limestone, N. Y.

IV, b, 15. *Zaphrentis.* Corniferous limestone, N. Y.

IV, b, 16. *Zaphrentis.* Corniferous limestone, N. Y.

IV, b, 17. *Zaphrentis.* Corniferous limestone, N. Y.

IV, b, 18. *Pecten.* Tertiary locality. ?

IV, b, 19. Missing.

IV. b, 20. *Heliophyllum Halli*, E. & H. Hamilton group, Western N. Y.

IV, b, 21. Missing.

IV, b, 22. Water worn corals. Hamilton group, N. Y.

IV, b, 23. Coral. Probably European Jurassic.

*IV, b, 24. *Heliophyllum.* Corniferous limestone, N. Y.

IV, b, 25. *Favosites & Zaphrentis.* Corniferous limestone, N. Y.

IV, b, 26. Missing.

IV, b, 27. Organic Impressions. Clinton group (Gray band), Medina, N. Y.

IV, b, 28 (2 specimens). *Zaphrentis.* Corniferous limestone, N. Y

IV, b, 29. Missing.
IV, b, 30. Bryozoa. Trenton limestone, Central N. Y.
IV, b, 31. Bryozoa. Trenton limestone, Central N. Y.
IV, b, 32. *Heliophyllum.* Hamilton group, Western N. Y.
IV, b, 33. *Zaphrentis.* Corniferous limestone, Western N. Y.
IV, b, 34. Missing.
IV, b, 35. *Monticulipora lycoperdon.* Trenton limestone, N. Y.
IV, f, 1. *Favosites.* Corniferous limestone, Helderberg, N. Y.
IV, f, 2. *Favosites.* Corniferous limestone, Bethlehem, N. Y.
IV, f, 3. *Columnaria alveolata.* Black River limestone, N. Y.
IV, f, 4. *Favosites.* Corniferous limestone, Bethlehem, N. Y.
IV, f, 5. *Favosites.* Corniferous limestone, N. Y.
IV, f, 6. *Favosites.* Corniferous limestone, N. Y.
IV, f, 7. *Favosites.* Corniferous limestone, N. Y.
IV, f, 8. *Favosites.* Corniferous limestone, N. Y.
IV, f, 9. *Favosites.* Corniferous limestone, N. Y.
IV, f, 10. *Favosites.* Corniferous limestone.
IV, f, 11. *Favosites.* Niagara limestone.
IV, f, 12. *Favosites.* Corniferous limestone, N. Y.
IV, f, 13. *Favosites.* Corniferous limestone, N. Y.
IV, f, 14. *Favosites.* Corniferous limestone, N. Y.
IV, f, 15. *Favosites.* Corniferous limestone, N. Y.
IV, f, 16. *Favosites.* Niagara limestone, N. Y.
IV, f, 17. Missing.
IV, f, 18. Missing.
IV, f, 19. (3 specimens.) *Favosites.* Niagara limestone, N. Y.
IV, f, 20. Missing.
IV, f, 21. Missing.
IV, f, 22. *Zaphrentis.* Corniferous limestone, N. Y.
IV, f, 23. Missing.
IV, f, 24. *Favosites.* Niagara limestone, N. Y.
IV, f, 25. (2 specimens.) Niagara?
IV, f, 26. *Favosites.* Niagara limestone. Illinois and Wisconsin.
IV, g, 1. Graptolites. Hudson River slates? N. Y.
IV, k, 1. *Eridophyllum.* Corniferous limestone, Berne, N. Y.
IV, k, 2. *Eridophyllum.* Corniferous limestone, Berne, N. Y.
IV, k, 3. *Columnaria alveolata.* Trenton limestone, N Y.
IV, k, 4. *Columnaria alveolata.* Trenton limestone Glens Falls, N. Y.
IV, k, 5. *Columnaria alveolata.* Trenton limestone, Glens Falls, N. Y.

IV, k, 6. *Trachypora.* Corniferous limestone, N. Y.
IV, l, 1. *Syringopora.* Corniferous limestone, Bethlehem, N. Y.
IV, l, 2. *Syringopora.* Corniferous limestone, N. Y.
IV, m, 1. Sponge. Chalk, Wilts, England.
IV, r, 16. *Favosites.* Corniferous limestone, N. Y.
IV, r, 25. *Stromatopora.* Niagara limestone, N. Y.
V, 1. Missing.
V, 2. Water-worn coral.
V, 3. "Veget. Petrefact. in Hornstone. Coeymans." *Trematopora.* Delthyris shaly limestone.
V, 4. "Veget. Petrefact. Helderbergh." Casts of sponge tubes. Oriskany sandstone.
V, 5. "Veget. Petrefact. Helderbergh." Casts of sponge tubes. Oriskany sandstone.
V, 6. Missing.
V, 7. Epsomites. Niagara limestone, N. Y.
V, 8. Epsomites. Niagara limestone, N. Y.
V, 9. Epsomites. Niagara limestone, N. Y.
V, 10–12. Missing.
V, 13. Travertine. Danube, Herkimer county, N. Y.
V, 14–30. Missing.
V, 31. Silicified palm. Locality?
V, 32, 33. Missing.
V, 34. "Ferruginified birch roots. Fowler. St. Lawrence county."
V, 35. Missing.
V, 36. (2 specimens) *Orthoceras* sp.? Marcellus shales, Schoharie, N. Y.
V, 37, 38. Missing.
*V, 39. "*Lithodictuon Beckii,* from Medina, Orleans county, N. Y. (Grey band of Eaton.) Dr. G. W. Boyd."
V, 40, 41. Missing.
V, 42. *Arthophycus Harlani.* (3 specimens.) Medina, N. Y.

1. *Trigonia,* etc. Jurassic. Locality?
2. *Trigonia,* etc. Jurassic. Locality?
4. *Triarthrus Becki.* Green. Utica slate, N. Y.
4. *Orbiculoidea grandis.* Van. Hamilton group, Central N. Y.
4. *Streptelasma,* etc. Hamilton group, Western N. Y.
5. Corniferous limestone, N. Y.
5. *Scolithus.* Potsdam sandstone, N. Y.

*6+20+21+26. *Endoceras longissimum.* Hall. ORIGINAL. (Palæontology of New York, vol. I, pl. 18, figs. 1, 1a.) Black River limestone, Watertown, N. Y.

*7. *Gonioceras anceps.* Hall. Black River limestone, Watertown, N. Y.

8. *Murchisonia bellicincta.* Trenton limestone, Central N. Y.

9. *Murchisonia bellicincta.* Trenton limestone, Central N. Y.

10. *Edmondia subtruncata.* Hall. Trenton limestone, Central N. Y.

10. *Orthoceras*, Schoharie grit, N. Y.

11+13. *O. junceum*, Hall. Trenton limestone, Central N. Y.

12. *Edmondia subtruncata*, Hall. Trenton limestone, Central N. Y.

14. *Monticulipora.* Trenton limestone, Central N. Y.

15. *M. lycoperdon.* Trenton limestone, Central N. Y.

*16+23. *Gonioceras anceps*, Hall. Black Biver limestone, Watertown, N. Y.

18. *Monticulipora.* Trenton limestone, N. Y.

*19. *Gonioceras anceps*, Hall. Black River limestone, Watertown, N. Y.

21. Pentamerus limestone, Rochester, N. Y.

*22. *Ormoceras ? gracile*, Hall. ORIGINAL. (Palæontology of New York, vol. 1, pl. 17, fig. 3.) Black River limestone, Watertown N. Y.

25. *Stromatocerium rugosum*, Hall. Watertown, N. Y.

26. *Tetradium.* Watertown, N. Y.

27. *Stromatocerium rugosum*, Hall. Watertown, N. Y.

*28. *Endoceras proteiforme*, var. *tenuistriatum*, Hall. Trenton limestone, Central N. Y.

29. *Edmondia subtruncata*, Hall. Trenton limestone, Central N. Y.

31. *Pterinea flabella*, Conr. Hamilton group, Central N. Y.

45. *Spirifer arrectus*, Conr. Oriskany sandstone, N. Y.

136. *Halysites catenulata.* Niagara group, N. Y.

SPECIMENS WITH PRINTED NUMBERS.

445, 471, 502. *Spirifer mesastrialis*, Hall. *Modiomorpha* and other fossils. Chemung group, N. Y.

58, 376, 424. *Limoptera macroptera*, Conr. Hamilton group, N. Y.

53. *Spirifer.* Lower Carboniferous. Locality?

119. *Heliophyllum Halli*, E. & H. Hamilton group, Western N. Y.

72, 304. *Orthoceras.* Hamilton group, Central N. Y.

444, 454, 81, 464. *Spirifer granulosus*, Conr. Hamilton group, Central N. Y.

43. *S. audaculus*, Conr. Hamilton group, Central N. Y.

71. *Cimitaria recurva*, Conr. Hamilton group, Central N. Y.

84. *Spirifer mucronatus*, Conr. Hamilton group, Rensselaerville, N. Y.

22. *Favosites.* Niagara group, N. Y.

*a. Potsdam sandstone, N. Y.

b. *Pholadomya.* Jurassic, Europe.

b. *Zaphrentis.* Corniferous limestone, N. Y.

c. *Cucullæa.* Cretaceous, Europe.

c. *Columnaria.* Black River limestone, N. Y.

d, f. *Monticulipora lycoperdon.* Trenton limestone, N. Y.

*e. *Orthoceras nuntium*, Hall. Hamilton group, Central N. Y.

k. *Leptæna rhomboidalis*, Wilck. Corniferous limestone, N. Y

0.1 ? Corniferous, Ky.

0.3. ? Corniferous, Ky.

t, u, v. Various fossils. Hudson River group (erratic blocks), N. Y.

a, a. (Two specimens) *Monticulipora lycoperdon.* Trenton limestone, N. Y.

*b, b. *Tentaculites gyracanthus*, Eaton. Tentaculite limestone, Schoharie, N. Y.

c, c. *Grammysia arcuata*, Conr. Hamilton group, N. Y.

d, d. Cetacean ? bones. Locality ?

e, e. Silicified wood. Locality ?

f, f. *Batrachoides nidificans*, Hitchcock. Triassic sandstone, Connecticut Valley, Mass.

g, g. Various fossils. Hamilton group, N. Y.

h, h. *Orthoceras undulatum*, Hall. Niagara limestone, Western New York.

o, o. *O. Marcellense*, Hall. Goniatite limestone, Schoharie, N. Y

N. 1. *Conocardium trigonale*, Conr. Corniferous limestone, Schoharie, N. Y.?

N. 2. *Leperditia alta*, Conr. Tentaculite limestone, Schoharie, N. Y

N. 3. Corniferous limestone, Schoharie, N. Y.

*N. 4. *Favosites tuberosa*, Rom. Corniferous limestone, Schoharie. N. Y.

N. 5. *Zaphrentis.* Corniferous limestone, Schoharie, N. Y.

N. 6. *Favosites.* Corniferous limestone, Schoharie, N. Y.

N. 7. *Platyceras dumosum*, Çonr. Corniferous limestone, Schoharie harie, N. Y.

N. 8. *Megambonia bellistriata*, Hall. Oriskany limestone, Schoharie, N. Y.

*N. 9. *Terebratula?* Corniferous limestone, Schoharie, N. Y.

*N. 10. *Ptilodictya.* Corniferous limestone, Schoharie, N. Y.

N. 11. *Favosites tuberosa*, Rom. Corniferous limestone, Schoharie, N. Y.

N. 12. *Favosites.* Corniferous limestone, Schoharie, N. Y.?

N. 13. *Pterinœa arenaria*, Hall. Oriskany sandstone, Schoharie, N. Y.

E. 3. Fish tooth. Locality?

E. 4. Fish tooth. Locality?

E. 7. Fish tooth. Locality?

E. 6. Fish tooth. Locality?

E. 9. Fish tooth. Locality?

G. *Trinucleus concentricus.* Trenton limestone, N. Y

G. Hamilton group?

H. *Trinucleus concentricus.* Trenton limestone, N. Y.

I. *Leptœna rhomboidalis.* Corniferous limestone, N. Y.

I. *Edmondia subtruncata*, Hall. Trenton limestone, N. Y.

L. ? ?

M. ? ?

P. 1. Pentamerus limestone. Clinton group. Western, N. Y.

P. 2. *Spirifer granulosus*, Conr. Hamilton group, N. Y.

P. 3. *Conocardium.* Corniferous limestone, N. Y.

P. 4.

P. 5. *Limoptera?* Hamilton group, N. Y.

P. 6. *Spirifer granulosus*, Conr. Hamilton group, N. Y.

P. 7. *Orthoceras crotalum*, Hall. Hamilton group, N. Y.

S. *Pentamerus oblongus*, Hall. Clinton group, Rochester, N. Y.

X. *Astarte.* Cretaceous. Locality.?

Fossils without Labels or Tickets.

Columnaria alveolata (2 specimens). Black River limestone, N. Y.

Bellerophon bilobatus Conr. Trenton limestone, N. Y.

Raphistoma lenticulare. Trenton limestone, N. Y.

Orthis biforata Eich. Hudson River group, Ohio.

Ambonychia radiata. Hudson River group, N. Y.

Cyrtolites ornatus. Hudson River group, N. Y.

**Pleurotomaria? pervetusta*, Hall. Medina sandstone, N. Y.

Pentamerus oblongus var. Niagara group, Iowa.

Caryocrinus ornatus, Hall (2 specimens). Niagara group, Lockport, N. Y.

Spirifer Niagarensis, Hall. Niagara group.

Halysites catenulata. Niagara group, N. Y.

Epsomites. Niagara group, N. Y.

Spirifer macropleura, Conrad. Lower Helderberg group, N. Y.

Meristella lævis, Hall. Lower Helderberg group, N. Y.

Leperditia alta, Conrad. Lower Helderberg group, N. Y.

Pentamerus galeatus, Dal. Lower Helderberg group, N. Y.

Spirifer arenosus, Conr. Oriskany sandstone, N. Y.

S. arrectus, Hall (2 specimens). Oriskany sandstone, N. Y.

Rensselæria ovoides, Hall (3 specimens). Oriskany sandstone, N. Y.

R. ovalis, Hall. Oriskany sandstone, N. Y.

Eatonia peculiaris, Hall (2 specimens). Oriskany sandstone, N. Y.

Orthoceras. Schoharie grit, N. Y.

Atrypa reticularis (19 specimens). Corniferous limestone, N. Y.

One lot corals (15 specimens). Corniferous limestone, N. Y.

Athyris spiriferoides Eaton (34 specimens). Hamilton group, Western N. Y.

One misc. lot brachiopods (15 specimens). Hamilton group, Western N. Y.

Grammysia alveata. Hamilton group, Western N. Y.

Cimitaria recurva. Hamilton group, Western, N. Y.

Limoptera macroptera (2 specimens). Hamilton group, Western N. Y.

One lot corals (10 specimens). Hamilton group, Western N. Y.

Misc. brachiopods (4 specimens). Chemung group, N. Y.

One lot Tertiary fossils. Locality?

One lot carboniferous plants from Carbondale, Pittston, Plymouth, etc., Penna. (58 specimens).

One lot carboniferous plants from Morgan county, Virginia.

Palæoniscus, Trias. Turner's Falls, Mass.

Skeleton of fish (2 specimens). Solenhofen, Germany.

Favosites. Niagara limestone, N. Y.

* *Orthoceras arcuoliratum,* Hall. Trenton limestone, Wisconsin.

Report of the Assistant Palæontologist.

ALBANY, NEW YORK, *September* 30, 1891.

JAMES HALL, LL. D., *State Geologist.*

SIR.— Early in the present year I received instructions to devote my time as far as possible to the requirements of the Palæontology of New York; as a necessary consequence museum work among the palæontological collections has progressed but little during the past year. The mounting of the crustacean collection has been advanced beyond its condition at date of last report, but still lacks considerably of completion. Important additions have, however, been made to the collections, and of these a list is communicated with this report. Opportunity for field work has been curtailed by the heavy expenditure connected with the geological investigations carried on at the Livonia salt shaft, which has been borne entirely by this department. We have received from Mr. D. D. Luther, who has conducted these investigations, one shipment of specimens, consisting of nineteen boxes and one barrel of fossils, mostly from the upper layers of the Hamilton shales, and a second lot of nine boxes from the middle part of this formation. At the time Mr. Luther began his work in May last, the excavation of the shaft had proceeded to a depth of about 350 feet; of this thickness about 125 feet pertained to the Hamilton shales, the rock section from 225 feet upward being wholly in the Genesee shales. The latter have furnished but the few, common species of the dark shales, the *styliola limestone* layer, which appears in the sections further to the east, being here represented by a few isolated concretions of small size. The fossils of the upper Hamilton shales collected from the dump of the shaft, representing the section from 225–350 feet, have been examined and identified by me, and a list of these with the other fossils of this series of formations will be submitted when a final report on this interesting section shall be rendered. The material thus far examined has been found very rich in trilobites, linguloids and lamellibranchs; the linguloids especially being remarkable for their diversity of form and beauty of preservation.

Late in the autumn of last year Mr. Jacob Van Deloo made some collections of fossils from the Chazy limestone at Keeseville, and in September of this year he, with Mr. Martin Sheehy, collected considerable valuable material from the interesting Oriskany fauna on Becraft's Mountain, near Hudson, discovered last year by Dr. C. E. Beecher of New Haven.

About a year ago I began the preparation of a series of lists of the type and illustrated specimens of fossils belonging to the Museum collections. The lists heretofore published have been fragmentary and scattered; it has been my purpose to bring together in a zoological arrangement an enumeration, complete to date, of these important specimens, with citations to the publications in which they have been figured. I transmit herewith the first installment of this catalogue, viz., Part I, *Crustacea.*

The work done on the Palæontology of New York, vol. VIII, parts 1 and 2, is fully recounted in your own report.

I am, sir, very respectfully yours.

J. M. CLARKE,
Assistant Palæontologist.

DEPARTMENT OF GEOLOGY AND PALÆONTOLOGY.

List of the Original and Illustrated Specimens in the Palæontological Collections

PART I.----CRUSTACEA.

PREPARED BY JOHN M. CLARKE, ASSISTANT PALÆONTOLOGIST.

PREFATORY NOTE.

The fundamental arrangement in this list is a zoological one; the subordinate arrangement of species under genera is chronological. The combinations of generic and specific names are those adopted in the work where the species have been most fully discussed and illustrated. For the classification of the genera, however, the writer is alone responsible. The collections of the Museum include a considerable number of reproductions in plaster-of-paris, gutta-percha and sulphur, of original specimens, and these are, for convenience of reference, included in the list, but the citations of these are marked with an asterisk (*) in the margin of the page. The actual original specimens, including those used for the first illustration of the species, are indicated by having the reference to the illustration in heavy-face type.

OSTRACODA.

Family LEPERDITIDÆ.

Genus LEPERDITIA, Rouault. 1851.

Leperditia Hudsonica, Hall. 1859.

Palæontology of New York, vol. iii, p. 375.

Quarterly Journal of the Geological Society, vol. xlvi, pl. 1, figs. **5, a, b, c.**

Lower Helderberg group (Shaly limestone). Becraft's Mountain, N. Y.

Leperditia alta, Conrad (sp.). 1843.

In Vanuxem's Report on the Third Geological District of New York, p. 112.

Quarterly Journal of the Geological Society, vol. xlvi, pl. 1, figs. 6, a, b.

Lower Helderberg group (Tentaculite limestone). Herkimer county, N. Y.

Genus BEYRICHIA, McCoy. 1844.

Beyrichia trisulcata, Hall. 1859.

Palæontology of New York, vol. iii, p. 381.

Quarterly Journal of the Geological Society, vol. xlvi, pl. 1, fig. **2.**

Lower Helderberg group (Tentaculite limestone). Herkimer county, N. Y. *J. Gebhard purchase.*

Beyrichia granulata, Hall. 1859.

Palæontology of New York, vol. iii, p. 377.

Quarterly Journal of the Geological Society, vol. xlvi, pl. 1, fig. **3.**

Lower Helderberg group (Pentamerus limestone). Schoharie county, N. Y. *J. Gebhard purchase.*

Beyrichia oculina, Hall. 1859.

Palæontology of New York, vol. iii, p. 378.

Quarterly Journal of the Geological Society, vol. xlvi, pl. 1, fig. **4.**

Lower Helderberg group (Pentamerus limestone). Schoharie county, N. Y. *J. Gebhard purchase.*

Beyrichia parasitica Hall, (sp.). 1859.

Palæontology of New York, vol. iii, p. 376.

Quarterly Journal of the Geological Society, vol. xlvi, p. 17, fig. 1.

Lower Helderberg group (Tentaculite limestone). Herkimer county N. Y. *J. Gebhard purchase.*

Beyrichia Clarkii, Jones. 1890.

Quarterly Journal of the Geological Society, vol. xlvi, p. 17, fig. 2.

Lower Helderberg group (Tentaculite limestone). Herkimer county, N. Y. *J. Gebhard purchase.*

Beyrichia subquadrata, Jones. 1890.

Quarterly Journal of the Geological Society, vol. xlvi, p. 537, pl. xx, fig. 4.

Corniferous limestone (drift). Canandaigua, N. Y.

J. M. Clarke purchase.

Beyrichia Klœdeni, McCoy. var.

Quarterly Journal of the Geological Society, vol. xlvi, p. 538, pl. 21 fig. 1a, b.

Corniferous limestone (drift). Canandaigua, N. Y.

J. M. Clarke purchase.

Beyrichia Kolmodini, Jones. 1890.

Quarterly Journal of the Geological Society, vol. xlvi, p. 538, pl. 20, fig. 6.

Hamilton group. Clarke county, Indiana.

J. M. Clarke purchase.

Genus PRIMITIA, Jones and Holl, 1865.

Primitia Clarkii, Jones. 1890.

Quarterly Journal of the Geological Society, vol. xlvi, p. 535, pl. 21, fig. 11.

Corniferous limestone (drift). Canandaigua, N. Y.

J. M. Clarke purchase.

Genus KLŒDENIA, Jones and Holl. 1886.

Klœdenia notata, Hall (sp.), var. *ventricosa*, Hall. 1859.

Palæontology of New York, vol. iii, p. 380.

Quarterly Journal of the Geological Society, vol. xlvi, p. 14, pl. 1, figs. 1, a, b.

Lower Helderberg group (Shaly limestone). Herkimer county, N. Y.

J. Gebhard purchase.

Genus **BOLLIA**, Jones and Holl. 1886.

Bollia bilobata, Jones. 1890.

Quarterly Journal of the Geological Society, vol. xlvi, p. 540, pl. 20, fig. 12.

Corniferous limestone (drift). Canandaigua, N. Y.

J. M. Clarke purchase.

Genus **MOOREA**, Jones and Kirby.

Moorea Kirbyi, Jones. 1890.

Quarterly Journal of the Geological Society, vol. xlvi, p. 542, pl. 20, fig. 9, a, b.

Corniferous limestone (drift). Canandaigua, N. Y.

J. M. Clarke purchase.

Genus **OCTONARIA**, Jones.

Octonaria Linnarssoni, Jones. 1890.

Quarterly Journal of the Geological Society, vol. xlvi, p. 541, pl. 20, fig. 7, a, b.

Hamilton group. Clarke county, Indiana.

J. M. Clarke purchase.

Genus **EURYCHILINA**, Ulrich.

Eurychilina reticulata, Ulrich (Jones. 1890).

Quarterly Journal of the Geological Society, vol. xlvi, p. 539, pl. 20. fig. 13, a, b.

Corniferous limestone (drift). Canandaigua, N. Y.

J. M. Clarke purchase.

CIRRIPEDIA.

Family LEPADIDÆ.

Genus **TURRILEPAS**, Woodward. 1865.

Turrilepas flexuosus, Hall. 1888.

Palæontology of New York, vol. vii, p. 215, pl. 36, fig. **1**.
Corniferous chert. Canandaigua, N. Y.
J. M. Clarke purchase.

Turrilepas cancellatus, Hall. 1888.

Palæontology of New York, vol. vii, p. 216, pl. 36, fig. **2**.
Corniferous chert. Canandaigua, N. Y.
J. M. Clarke purchase.

Turrilepas devonicus, Clarke. 1882.

American Journal of Science, vol. xxiv, p. 55, fig. **1**.
Palæontology of New York, vol. vii, 1888, pl. 36, fig. **3**.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Turrilepas squama, Hall. 1888.

Palæontology of New York, vol. vii, p. 217, pl. 36, fig. **5**.
Palæontology of New York, vol. vii, pl. 36, fig. **6**.
Palæontology of New York, vol. vii, pl. 36, fig. **7**.
Palæontology of New York, vol. vii, pl. 36, fig. **8**.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase

Turrilepas foliatus, Hall. 1888.

Palæontology of New York, vol. vii, p. 218, pl. 36, fig. **15**.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase

Turrilepas nitidulus, Hall. 1888.

Palæontology of New York, vol. vii, p. 218, pl. 36, fig. **4**.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase

Turrilepas tener, Hall. 1888.

Palæontology of New York, vol. vii, p. 219. pl. 36, figs. **9, 10, 11, 12, 13.**
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, pl. 36, fig. **14.**
Hamilton group, Canandaigua lake, N. Y.
J. M. Clarke purchase.

Turrilepas ? Newberryi, Whitfield. 1882.

Annals N. Y. Academy of Sciences, vol. ii, no. 8, p. 217.

*Palæontology of New York, vol. vii, pl. 36, fig. **17.**
*Palæontology of New York, vol. vii, pl. 36, fig. **19.**
Erie shale. Sheffield, Ohio.

Genus **STROBILEPIS**, Clarke. 1888.

Strobilepis spinigera, Clarke. 1888.

Palæontology of New York, vol. vii, p. 212, pl. 36, figs. **20, 21, 22.**
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1861.

Family BALANIDÆ.

Genus **PALÆOCREUSIA**, Clarke. 1888.

Palæocreusia devonica, Clarke. 1888.

Palæontology of New York, vol. vii, p. 210, pl. 36, figs. **24, 25, 26.**
Corniferous limestone. LeRoy, N. Y.
Collected by C. D. Walcott and C. Van Deloo, 1878.

TRILOBITA.

Family NUTTAINIIDÆ.

Genus **NUTTAINIA**, Eaton. 1832.

**Nuttainia concentrica*, Eaton. 1832.

Monograph of the Trilobites of North America, p. 73. Cast No. **28.**
Trenton limestone. Near Waterford, N. Y.
The Albany Institute donor.

Family CALYMENIDÆ.

Genus **CALYMENE**, Brongniart. 1822.

* *Calymene callicephala*, Green. 1832.

Monograph of the Trilobites of North America, p. 30. Cast No. **2.**
Hudson River group. Locality said to be Hampton, Virginia.
The Albany Institute donor.

*(*C. Blumenbachi* [Brongniart] Green).

Monograph of the Trilobites of North America, p. 28. Cast No. **1.**
Trenton limestone. Trenton Falls, N. Y.
The Albany Institute donor.

Calymene camerata, Conrad. 1842.

Journal Philadelphia Academy Natural Science, vol. viii, p. 278.

Palæontology of New York, vol. ii, 1852, pl. 78, fig. **1a.**
Niagara group (Coralline limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. ii, 1852, pl. 78, fig. **1b.**
Niagara group (Coralline limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. ii, 1852, pl. 78, figs. **1c, 1e.**
Niagara group (Coralline limestone). Schoharie, N. Y.
J. Gebhard purchase.

Calymene platys, Green. 1832.

Monograph Trilobites of North America, p. 32.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 1, fig. 3; and Palæontology of New York, vol. vii, 1888, pl. 1 fig. 1.

Schoharie grit. Schoharie, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 1, fig. 2; and Palæontology of New York, vol. vii, 1888, pl. 1, fig. 2.

Schoharie grit. Albany county, N. Y.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 1, figs. 4, 7, and Palæontology of New York, vol. vii, 1888, pl. figs. 3, 7.

Schoharie grit. Schoharie, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 1, fig. 5; and Palæontology of New York, vol. vii, 1888, pl. fig. 4.

Schoharie grit. Schoharie, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 1, fig. 6; and Palæontology of New York, vol. vii, 1888, pl. 1, fig. 5.

Schoharie grit. Schoharie, N. Y.

Collected by C. Van Deloo. 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 1, fig. 1; and Palæontology of New York, vol. vii, 1888; pl. 1, fig. 6.

Schoharie grit. Knox, N. Y.

Collected by C. Van Deloo. 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 1, fig. 9; and Palæontology of New York, vol. vii, 1888, pl. 1, fig. 8.

Schoharie grit. Schoharie county, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 1, fig. 8; and Palæontology of New York, vol. vii, 1888, pl. 1, fig. 9.

Schoharie grit. Schoharie county, N. Y.

Genus **HOMALONOTUS**, Kœnig. 1825.

Sub-genus **TRIMERUS**, Green, 1832.

Homalonotus delphinocephalus, Green. 1832.

Monograph of the Trilobites of North America, p. 82, pl. 1, fig. 1; original of Cast No. 32.

Niagara group. "In limestone. Banks of Lake Ontario, Monroe county, N. Y."

The Albany Institute donor.

Monograph of the Trilobites of North America, p. 82; not figured.

Niagara group. Western New York.

The Albany Institute donor.

Palæontology of New York, vol. ii, 1852, pl. 68, fig. 9.

Niagara group. Lockport, N. Y.

Homalonotus Vanuxemi, Hall. 1859.

Palæontology of New York, vol. iii, p. 352, pl. 73, fig. 12.

Lower Helderberg group. Schoharie, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 5b, figs. 1, 2.

Lower Helderberg group. Kingston, N. Y.

L. Bevier, exchange.

Homalonotus major, Whitfield. 1885.

Bull. Amer. Mus. Nat. His. Vol. i, No. 6, p. 193, pl. 22.

Palæontology of New York, vol. vii, 1888, pl. 5a, fig. 1.

(Oriskany sandstone). Bank of 4th Binnewater, Rosendale, N. Y.

L. Bevier, exchange.

Subgenus **DIPLEURA**, Green. 1832.

Homalonotus DeKayi, Green (sp.). 1832.

Monograph of the Trilobites of North America, p. 80, not figured.

Hamilton group. Madison county, N. Y.

The Albany Institute donor.

(*) (*Nuttainia sparsa*, Eaton.)

Geological Text-book, 2nd ed., 1832, p. 34.

Monograph of the Trilobites of North America, p. 89, Cast No. 35.

Hamilton group. Coeymans, N. Y.

The Albany Institute donor.

(*) Monograph of the Trilobites of North America, p. 79, Cast No. **31.**
Hamilton group. Northumberland, Pa. (?)
The Albany Institute donor.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 2, fig. 1; and Palæontology of New York, vol. vii, 1888, pl. 2, fig. 1.
Hamilton group. Madison county, N. Y.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 2, fig. 2; and Palæontology of New York, vol. vii, 1888, pl. 2, fig. 2.
Hamilton group. Ladd's quarry near Sherburne, Chenango county, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 2, fig. 6; and Palæontology of New York, vol. vii, 1888, pl. 2, fig. 6.
Hamilton group. Madison or Otsego county, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 2, fig. 7; and Palæontolgy of New York, vol. vii, 1888, pl. 2, fig. 7.
Hamilton group. Madison county, N. Y.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 2, figs. 8, 9; and Palæontology of New York, vol. vii, 1888, pl. 2, figs. 8, 9.
Hamilton group. Madison county, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 2, fig. 11; and Palæontology of New York, vol. vii, 1888, pl. 2, fig. 11.
Hamilton group. Darien, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illusfrations of Devonian Fossils, 1876; Crustacea, pl. 2, fig. 12; and Palæontology of New York, vol. vii, 1888, pl. 2, fig. 12.
Hamilton group. Cazenovia, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 3, fig. 1; and Palæontology of New York, vol. vii, 1888, pl. 3, fig. 1.
Hamilton group. Bellona, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 3, fig. 2; and Palæontology of New York, vol. vii, 1888, pl. 3, fig. 2.

Hamilton group. Near Leonardsville, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 3, fig. 3; and Palæontology of New York, vol. vii, 1888, pl. 3, fig. 3.

Hamilton group. Madison county, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 3, fig. 4; and Palæontology of New York, vol. vii. 1888, pl. 3, fig. 4.

Hamilton group. Canandaigua Lake, N. Y.

Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 3, fig. 5; and Palæontology of New York, vol. vii, 1888, pl. 3, fig. 5.

Hamilton group. Madison county, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 4, figs. 3, 4, 5; and Palæontology of New York, vol. vii, 1888, pl. 4, figs. 1, 2, 3.

Hamilton group. Madison county, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 4, fig. 6.

Hamilton group. Canandaigua Lake, N. Y.

J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 4, fig. 7.

Hamilton group. Canandaigua Lake. N. Y.

J. M. Clarke purchase.

Palæntology of New York, vol. vii, 1888, pl. 5, fig. 1.

Hamilton group. Pratt's Falls, N. Y.

Collected by C. Van Deloo and H. H. Smith, 1873.

Palæontology of New York, vol. vii, 1888, pl. 5, figs. 2, 3.

Hamilton group. Canandaigua Lake, N. Y.

J. M. Clarke purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 5, figs. 10, 9, and Palæontology of New York, vol. vii, 1888, pl. 5, figs. 12, 13.

Hamilton group. Hamilton, N. Y.

Collected by James Hall, 1862.

Family ASAPHIDÆ.

Genus BUMASTUS, Murchison.

Illænus Ioxus, Hall. 1867.

Twentieth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 378.

Eleventh Annual Report of the Department of Geology and Natural History (Indiana), 1882, pl. 33, fig. 13.

Niagara group. Waldron, Indiana.

Collected by C. D. Walcott and C. Van Deloo, 1878.

Eleventh Annual Report of the Department of Geology and Natural History (Indiana) 1882, pl. 33, fig. 14.

Niagara group. Waldron, Indiana.

Collected by C. D. Walcott and C. Van Deloo, 1878.

Illænus arcturus, Hall. 1847.

Palæontology of New York, vol. i, p. 23, pl. iv bis., fig. **12.**

Chazy limestone. Chazy, N, Y.

Geological Survey Collection.

Genus BATHYURUS, Billings. 1865.

Bathyurus extans, Hall. 1847.

Palæontology of New York, vol. i, p. 228, pl. lx, figs. **2, a, b.**

Birdseye limestone. Watertown, N. Y.

J. Gebhard purchase.

Genus ASAPHUS, Brongniart. 1822.

Asaphus obtusus, Hall. 1847.

Palæontology of New York, vol. i, p. 24, pl. iv bis., fig. **14.**

Chazy limestone. Chazy, N. Y.

Geological Survey Collection.

Asaphus canalis (Conrad), Hall. 1847.

Palæontology of New York, vol. i, p. 25, pl. iv bis., fig. **17.**

Chazy limestone. Chazy, N. Y.

Geological Survey Collection.

Palæontology of New York, vol. i, pl. iv bis., fig **19.**

Chazy limestone. Chazy, N. Y.

Geological Survey Collection.

Genus **ISOTELUS**, De Kay. 1824.

**Isotelus gigas*, De Kay. 1824.

Annals of the New York Lyceum of Natural History, vol. i, p. 124, pl. xiii, fig. 1.

Trenton limestone. Trenton Falls, N. Y.

The Albany Institute donor.

Family BRONTEIDÆ.

Genus **BRONTEUS**, Goldfuss. 1843.

Bronteus Barrandii, Hall. 1859.

Palæontology of New York, vol. iii, p. 350, pl. 73, figs. 1, 2, 3, 4.

Lower Helderberg group. Schoharie, N. Y.

J. Gebhard purchase.

Bronteus senescens, Clarke. 1889.

Eighth Annual Report N. Y. State Geologist, p. 57. fig. 1.

Chemung group. Prattsburgh, N. Y.

J. M. Clarke donor.

Subgenus **THYSANOPELTIS**, Corda. 1847.

Bronteus Tullius, Hall. 1888.

Palæontology of New York, vol. vii, p. 12, pl. 8a., figs. 34, 35.

Tully limestone. Kingsley's Hill, near Otisco, N. Y.

S. G. Williams donor.

Palæontology of New York, vol. vii, pl. 8a., fig. 36.

Tully limestone. Borodino, N. Y.

S. G. Williams donor.

Family PHACOPIDÆ.

Genus **PHACOPS**, Emmrich. 1839.

Phacops Logani, Hall. 1859.

Palæontology of New York, vol. iii, p. 353, pl. 73, fig. 15; and Palæontology of New York, vol. vii, 1888, pl. 8a., fig. 19.

Lower Helderberg group. Schoharie, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. iii, pl. 73, figs. 23, 24.

Lower Helderberg group. Schoharie, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. vii, pl. 8a., fig. 20.
Lower Helderberg group. Schoharie, N. Y.
J. Gebhard purchase.

Phacops cristata, Hall. 1861.

Descr. New Species Fossils, p. 67.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, figs. **1, 2**; and Palæontology of New York, vol. vii, 1888, pl. 6, figs. **1, 2.**
Schoharie grit. Knox, N. Y.
Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, figs. **3, 4**; and Palæontology of New York, vol. vii, 1888, pl. 6, figs. **3, 4.**
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, fig. **5**; and Palæontology of New York, vol. vii, 1888, pl. 6, fig. **5.**
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, figs. **9, 10**; and Palæontology of New York, vol. vii, 1888, pl. 6, figs. **6, 7.**
Schoharie grit. Albany county, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, fig. **11**; and Palæontology of New York, vol. vii, 1888, pl. 6, fig. **8.**
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, fig. **6**; and Palæontology of New York, vol. vii, 1888, pl. 6, fig. **9.**
Schoharie grit. Near Clarksville, N. Y.
Collected by R. P. Whitfield and C. Van Deloo, 1861.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, fig. **7**; and Palæontology of New York, vol. vii, 1888, pl. 6, fig. **10.**
Schoharie grit. Albany county, N. Y.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, figs. **12, 13**; and Palæontology of New York, vol. vii, 1888, pl. 6, figs. **12, 13.**
Schoharie grit. Schoharie, N. Y.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, fig. **19**; and Palæontology of New York, vol. vii, 1888, pl. 6, fig. **26.**
Schoharie grit. Schoharie, N. Y.
Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, fig. **16**; and Palæontology of New York, vol. vii, 1888, pl. 6, fig. **27.**
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, fig. **18**; and Palæontology of New York, vol. vii, 1888, pl. 6, fig. **28.**
Corniferous limestone. Near Clarence, N. Y.
Collected by R. P. Whitfield and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, fig. **17**; and Palæontology of New York, vol. vii, 1888, pl. 6, fig. **29.**
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1861.

(*) Palæontology of New York, vol. vii, 1888, pl. 8a, figs. 1, 2.
Schoharie grit. Albany county, N. Y.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 3.
Schoharie grit. Knox, N. Y.
Collected by C. Van Deloo, 1862.

Palæontolgy of New York, vol. vii, 1888, pl. 8a, fig. 4.
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1862.

Phacops cristata var. *pipa,* Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 18, pl. 8a, fig. **5.**
Corniferous limestone. LeRoy, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, 1888, pl. 8a, fig. **9.**
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

(*) Palæontology of New York, vol. vii, plate 8a, fig. **10.**
Corniferous limestone. North Cayuga, Ontario.

Palæontology of New York, vol. vii, pl. 8a, figs. **11, 12.**
Corniferous limestone. Walpole, Ontario.
Collected by C. D. Walcott, 1878.

Palæontology of New York, vol. vii, pl. 8a, fig. **14.**
Corniferous limestone. Lime Rock, near LeRoy, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, vol. vii, pl. 8a, fig. **15.**
Corniferous limestone. Canandaigua, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, vol. vii, pl. 8a, fig. **17.**
Oriskany sandstone. Cayuga, Ontario.
Collected by C. D. Walcott, 1878.

Palæontology of New York, vol. vii, pl. 8a, fig. **18.**
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 31.
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, figs. 25, 26.
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Phacops bufo, Green. 1832.

(*) Monograph of the Trilobites of North America, p. 41, Cast No. **10.**
Illustration of Devonian Fossils, 1875; Crustacea, pl. 8, figs. **24, 25**; and Palæontology of New York, vol. vii, 1888, pl. 8, figs. **25, 26.**
Hamilton group. New Jersey.
The Albany Institute donor.

Phacops rana, Green. 1832.

Monograph of the Trilobites of North America, 1832, p. 42; originals of Casts Nos. **11** and **12.**
Hamilton group. Seneca, Ontario county, N. Y.
The Albany Institute donor.

(*) (*Calymene macrophthalma* (Brongniart), Green=*C. bufo*, Green.)

Monograph of the Trilobites of North America, 1832, pp. 39, 41, Cast No. 9.

Hamilton group. Locality?

The Albany Institute donor.

Illustrations Devonian Fossils, 1876; Crustacea, pl. 7, fig. 1; and Palæontology of New York, vol. vii, 1888, pl. 7, fig. 1.

Hamilton group. Geneseo, N. Y.

Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 7, fig. 5; and Palæontology of New York, vol. vii, 1888, pl. 7, fig. 5.

Hamilton group. Darien, N. Y.

Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 7, fig. 9; and Palæontology of New York, vol. vii, 1888, pl. 7, fig. 6.

Hamilton group. Geneseo, N. Y.

Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 7, figs. 6, 7; and Palæontology of New York, vol. vii, 1888, pl. 7, figs. 7, 8.

Hamilton group. Canandaigua Lake, N. Y.

Collected by R. P. Whitfield and C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 7, fig. 8; and Palæontology of New York, vol. vii, 1888, pl. 7, fig. 9.

Hamilton group. Canandaigua Lake, N. Y.

Collected by R. P. Whitfield and C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 7, figs. 10, 11 and Palæontology of New York, vol. vii, 1888, pl. 7, figs. 10, 11.

Hamilton group. Canandaigua Lake.

Collected by R. P. Whitfield and C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 8, fig. 10; and Palæontology of New York, vol. vii, 1888, pl. 8, fig. 11.

Hamilton group. Darien, N. Y.

Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 8, fig. 12; and Palæontology of New York, vol. vii, 1888, pl. 8, fig. 13.
Hamilton group. Geneseo, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 8, fig. 14; and Palæontology of New York, vol. vii, 1888, pl. 8, fig. 15.
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 8, figs. 15, 16; and Palæontology of New York, vol. vii, 1888, pl. 8, figs. 16, 17.
Hamilton group. Canandaigua Lake, N. Y.
Collected by R. P. Whitfield and C. Van Deloo, 1858.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 21.
Hamilton group. Eighteen-mile Creek, N. Y.
F. A. Randall purchase.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 22.
Hamilton group. Darien, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 28.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 29.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 30.
Hamilton group. Fultonham, N. Y.
Collected by W. M. Gabb, 1857.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 31.
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 32.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 33.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 8.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii. 1888, pl. 21, fig. 9.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 10.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 15.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 17.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 19.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 20.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 21.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 30.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Phacops anceps, Clarke. 1890.

As Trilobitas do Grez de Ereré e Maecurú, Estado do Pará, Brazil, p. 16, pl. 1, fig. 3.
Corniferous limestone. Cayuga, Ontario.
Collected by C. D. Walcott, 1878.

Genus ODONTOCHILE, Corda. 1847.

Dalmanites vigilans, Hall. 1861.

Rept. Progress. Geol. Surv, Wisconsin, p. 57.

Eleventh Annual Report of the Department of Geology and Natural History (Indiana), 1882, pl. 83, fig. 9.

Niagara group. Waldron, Indiana.

Collected by C. D. Walcott and C. Van Deloo, 1878.

Dalmanites limulurus, Green. 1832.

(*Asaphus Wetherilli*, Green.)

Monograph of the Trilobites of North America, p. 57; original of Cast No. **20**.

Niagara limestone. Rochester, N. Y.

The Albany Institute donor.

(*Asaphus pleuroptyx*, Green.)

Monograph of the Trilobites of North America, p. 56; not figured.

Niagara limestone. Genesee River, N. Y.

The Albany Institute donor.

Dalmanites pleuroptyx, Green (sp.) 1832.

Monograph of the Trilobites of North America, p. 55; original of cast No. **18**.

Lower Helderberg group. Schoharie, N. Y.

The Albany Institute donor.

Palæontology of New York, vol. iii, 1859; pl. 74, fig. 6.

Lower Helderberg group (Shaly limestone). Schoharie, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 74, fig. 7.

Lower Helderberg group (Shaly limestone). Schoharie, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 11a, fig. 1.

Lower Helderberg group (Shaly limestone). Near Clarksville, N. Y.

J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1883, pl. 11a, fig. 3.

Corniferous limestone. Lime Rock, near LeRoy, N. Y.

Ward and Howell purchase.

Dalmanites micrurus, Green (sp.). 1832.

Monograph of the Trilobites of North America, p. 56, fig. **3**; original of Cast No. **19.**

Lower Helderberg group. The Helderberg, N. Y.

The Albany Institute donor.

Palæontology of New York, vol. iii, pl. 74, figs. 1, 2. (*Dalmania pleuroptyx.*)

Lower Helderberg group (Shaly limestone). Schoharie, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. iii, text, p. 359, woodcut.

Lower Helderberg group (Shaly limestone). Schoharie, N. Y.

J. Gebhard purchase.

Dalmanites glabratus, Green. 1832.

(*) Monograph of the Trilobites of North America, p. 52, Cast No. **17.**

Horizon uncertain. Locality said to be Ripley, Ohio.

The Albang Institute donor.

Dalmanites Meeki, Walcott. 1884.

Pal. Eureka Dist., p. 207, pl. 17, figs. 5, a, b.

(*) Palæontology of New York, vol. vii, pl. 11a, fig. **28.**

Lower Devonian. Eureka District, Nevada.

(*) Palæontology of New York, vol. vii, pl. 11a, figs. **29, 30.**

Lower Devonian. Eureka District, Nevada.

Dalmanites concinnus, Hall. 1876.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 10, fig. **3**; and Palæontology of New York, vol. vii, 1888, pl. 11a, fig. **9.**

Schoharie grit. Schoharie, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 10, figs. **4, 5**; Palæontology of New York, vol. vii, pl. 11a, figs. **10, 11.**

Schoharie grit. Schoharie,N. Y.

J. Gebhard purchase.

Dalmanites phacoptyx, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 31, pl. 11a, figs. **23, 24.**

Upper Helderberg group. North Cayuga, Ontario.

Collected by J. De Cew, 1866.

Palæontology of New York, vol. vii, pl. 11a, fig. **26.**
Upper Helderberg group. North Cayuga, Ontario.
Collected by J. De Cew, 1866.

Dalmanites anchiops, Green (sp.). 1832.

Monog. Tril. North Amer. p. 35.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 9, figs. 3, 4, and Palæontology of New York, vol. vii, 1888, pl. 9, figs. 2, 3.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 9, figs. 5, 6, 9 ; and Palæontology of New York, vol. vii, 1888, pl. 9, figs. 4, 5, 6 ; pl. 10, fig. **4.**
Schoharie grit. Schoharie county, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 9, fig. 10 ; and Palæontology of New York, vol. vii, 1888, pl. 9, fig. 12.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 10, fig. 8 ; and Palæontology of New York, vol. vii, 1888, pl. 10, fig. 5.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 10, figs. 10, 11 ; and Palæontology of New York, vol. vii, 1888, pl. 10, figs. 8, 9.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 10, fig. 10.
Schoharie grit. Knox, N. Y.
Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 10, fig. 13, and Palæontology of New York, vol. vii, 1888, pl. 10, fig. 12.
Schoharie grit. Schoharie,N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils. 1876; Crustacea, pl. 10, fig. 14; and Palæontology of New York, vol. vii, 1888, pl. 10, fig. 13.
Schoharie grit. Schoharie, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 9, fig. **12**; Palæontology of New York, vol. vii, 1888, pl. 9, fig. **13**.
Schoharie grit. Ulster county, N. Y.

Dalmanites anchiops, var. *armatus*, Hall. 1861.

Fifteenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 56.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 9, fig. **12**; and Palæontology of New York, vol. ii, 1888, pl. 9, fig. **7**.
Schoharie grit. Schoharie, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 9, fig. **7**; and Palæontology of New York, vol. vii, 1888, pl. 9, fig. **8**.
Schoharie grit. Near Clarksville, N. Y.

Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 9, fig. **8**; and Palæontology of New York, vol. vii, 1888, pl. 9, fig. **9**.
Schoharie grit. Schoharie, N. Y.

J. Gebhard purchase.

Dalmanites anchiops, var. *sobrinus*, Hall. 1888.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 9, fig. **11**; and Palæontology of New York, vol. vii, 1888, p. 62, pl. 9, fig. **11**.
Schoharie grit. Schoharie, N. Y.

Collected by C. Van Deloo, 1862.

Dalmanites macrops, Hall. 1861.

Descr. New Species Fossils, etc., p. 59.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 13, figs. **9, 10**; and Palæontology of New York, vol. vii, 1888, pl. 11a, figs. **14, 15**.
Corniferons limestone. Schoharie, N. Y.

J. Gebhard purchase.

Dalmanites erina, Hall. 1861.

Descr. New Species Fossils, etc., p. 62.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 13, figs. **3, 4**; and Palæontology of New York, vol. vii, 1888, pl. 11a, figs. **16, 17.**
Corniferous limestone. Clarence, N. Y.

Palæontology of New York, vol. vii, 1888, pl. 11a, fig. 18.
Corniferous limestone. Boulder in town of Naples, N. Y.
J. M. Clarke purchase.

Dalmanites Calypso, Hall. 1861.

Descr. New Species Fossils, etc., p. 61.

(*) Palæontology of New York, vol. vii, 1888, pl. 11a, figs. 19, 20.
Corniferous limestone. Sandusky, Ohio.

Genus **PROBOLIUM**, Œhlert. 1890.

Dalmanites tridens, Hall. 1859.

Palæontology of New York, vol. iii, 1859, p. 361, pl. 75, fig. **3.**
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 75, fig. **4.**
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 75, fig. **5.**
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 75, fig. **6.**
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard, purchase.

Dalmanites nasutus, Conrad (sp.). 1841.

Ann. Rept. Pal. Dept. N. Y., p. 48.

Palæontology of New York, vol. iii, 1859, pl. 75, fig. 2.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard, purchase.

Palæontology of New York, vol. iii, 1859, pl. 76, fig. 1.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard, purchase.

Palæontology of New York, vol. iii, 1859, pl. 76, fig. 2.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard, purchase.

Palæontology of New York, vol. iii, 1859, pl. 76, fig. 3.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard, purchase.

Palæontology of New York, vol. iii, 1859, pl. 76, figs. 4, 5, 6.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard, purchase.

Palæontology of New York, vol. iii, 1859, pl. 76, figs. 7, 8.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Genus **ODONTOCEPHALUS**. Conrad. 1840.

Dalmanites selenurus, Eaton (sp.). 1832.

Geol. Text-book, p, 31, pl. 1, fig. 1.

Palæontology of New York, vol. vii, 1888, pl. 11b, fig. 15.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 11b, figs. 16, 17.
Corniferous limestone. Canandaigua, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, vol. ii, 1888, pl. 11b, fig. 18.
Corniferous limestone. Phelps, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, vol. vii, 1888, pl. 11b. fig. 19.
Corniferous limestone. Canandaigua, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, vol. vii, 1888, pl. 11b, fig. 21.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 12, figs. 5, 6.
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 12, fig. 7.
Corniferous limestone. Canandaigua, N. Y.
Collected by J. M. Clarke, 1885.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 12, figs. 12, 13; and Palæontology of New York, vol. vii, 1888, pl. 12, figs. 8, 9.
Corniferous limessone. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 12, figs. 1, 2; and Palæontology of New York, vol. vii, 1888, pl. 12, figs. 10, 11.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 12, fig. 12.
Corniferous limestone. Lime Rock, near Le Roy, N. Y.
Collected by J. M. Clarke, 1885.

Dalmanites Ægeria, Hall. 1861.

Descr. New Species Fossils, etc., p. 57.

Palæontology of New York, vol. vii, 1888, pl. 11b, fig. 5.
Corniferous limestone. Williamsville, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York. vol. vii, 1888, pl. 11b, fig. 10.
Corniferous limestone. Clarence, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, vol. vii, 1888, pl. 11b, fig. 11.
Corniferous limestone. Clarence, N. Y.
Collected by J. M. Clarke, 1885.

Dalmanites bifidus, Hall. 1861.

Descr. New Species Fossils, p. 63.

Palæontology of New York, vol. vii, 1888, pl. 11b, figs. 2, 3.
Corniferous limestone. Lime Rock, near Le Roy, N. Y.
Collected by J. M. Clarke, 1886.

Palæontology of New York, vol. vii, 1888, plate 11b, figs. **24, 25.**
Corniferous limestone. Lime Rock, near Le Roy, N. Y.
Collected by J. M. Clarke, 1886.

Genus **CORYCEPHALUS**, Hall. 1888.

Dalmanites pygmæus, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p, 56, pl. 11, figs. **5, 6.**
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 11, figs. **7, 8.**
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Dalmanites dentatus, Barrett. 1876.

Amer. Journ. Science, vol. ii, 3d ser., p. 200.

Palæontology of New York, vol. vii, 1888, pl. 11a, fig. 5.
Lower Helderberg group. Port Jervis, N. Y.
Collected by J. W. Hall, 1877.

Palæontology of New York, vol. vii. 1888, pl. 11a, fig. 6.
Lower Helderberg group. Port Jervis, N. Y.
Collected by J. W. Hall, 1877.

Genus **CRYPHÆUS**, Green. 1837.

Dalmanites Boothi, Green (sp.). 1837.

Amer. Journ. Science, vol. 32, p. 343.

(? *Calymene microps,* Green. 1832.)

(*) Monograph of the Trilobites of North America, page 34, Cast No. **6.**

Said to be from a black limestone at Ripley, Ohio.
The Albany Institute donor.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, figs. 1, 2; and Palæontology of New York, vol. vii, 1888, pl. 16, figs. 1, 2, pl. 16a, fig. 8.

Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig. 5; and Palæontology of New York, pl. 16, fig. 3.

Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig. 6; and Palæontology of New York, vol. vii, 1888, pl. 16, fig. 4.
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig. 14; and Palæontology of New York, vol. vii, 1888, pl. 16a, fig. 4.
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig. 11; and Palæontology of New York, vol. vii, 1888, pl. 16a, fig. 5.
Hamilton group. Geneseo, N. Y.
Collected by C. A. White and C. Van Delo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig. 10; and Palæontology of New York, vol. vii, 1888, pl. 16a, fig. 6.
Hamilton group. Geneseo, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig. 12; and Paleontology of New York, vol. vii, 1888, pl. 16a, fig. 7.
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Dalmanites Boothi, var. *calliteles*, Green, (sp.). 1837.

Amer. Journ. Science, vol. xxxii, p. 346.

Palæontology of New York, vol. vii, 1888, pl. 16, fig. 5; 16a, fig. 12.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16, fig. 6; pl. 16a, fig. 13.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16, fig. 7; pl. 16a, fig. 14.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16, fig. 8.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, figs. 3, 4, and Palæontology of New York, pl. 16, figs. 9, 14, 15.
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Palæontology of New York, vol. vii, 1888, pl. 16, fig. 10.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16, figs. 11, 12.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16, fig. 13.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig. 7; and Palæontology of New York, vol. vii, 1888, pl. 16, fig. 16.
Hamilton group. Canandaigua, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig. 8; and Palæontology of New York, vol. vii, 1888, pl. 16, fig. 17.
Hamilton group. Canandaigua, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Palæontology of New York, vol. vii, 1888, pl. 16, figs. 19, 20, 21.
Hamilton group. Canandaigua, N. Y,
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16, fig. 22.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, pl. 16a, fig. 10.
Tully limestone. Goodwin's, Cayuga Lake, N. Y.
Donated by S. G. Williams.

Palæontology of New York, vol. vii, 1888, pl. 16a, fig. 15.
Hamilton group. Hopewell, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16a, fig. 16.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 22.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Dalmanites comis, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 41, pl. 16a, fig. 1.
Upper Helderberg group. Cayuga, Ontario.
Collected by C. D. Walcott, 1878.

Genus **CRYPHINA**, Œhlert. 1890.

Dalmanites serrulus, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 30, pl. 11a, fig. 12.
Corniferous limestone. North Cayuga, Ontario.

Genus **CORONURA**, Hall, 1888.

Dalmanites emarginatus, Hall. 1876.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 10, fig. 2; and Palæontology of New York, vol. vii, 1888, pl. 11a, fig. 7.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 11a, fig. 8.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Dalmanites aspectans, Conrad (sp.). 1841.

(=*Asaphus diurus*, Green. 1839.)

Fifth Ann. Rept. Pal. N. Y., p. 49, fig. 9.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 12, figs. 6, 8; and Palæontology of New York, vol. vii, 1888, pl. 13, figs. 3, 4.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 12, fig. 11; and Palæontology of New York, vol. vii, 1888, pl. 13, fig. 5.
Corniferous limestone. Columbus, Ohio.
Collected by R. P. Whitfield, 1865.

Palæontology of New York, vol. vii, pl. 13, fig. 9.
Corniferous limestone. Lime Rock, N. Y.
Collected by J. M. Clarke, 1885.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 10, fig. 1; and Palæontology of New York, vol. vii, pl. 13, fig. 13.
Corniferous limestone. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1865.

Dalmanites myrmecophorus, Green. 1835.

Suppl. Monogr. Tril. North Amer., p. 16.

Palæontology of New York, vol. vii, 1888, pl. 13, fig. 12.
Corniferous limestone. Lime Rock, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, vol. vii, 1888, pl. 14, fig. 1.
Corniferous limestone. Kingston, N. Y.
Tubbs purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 13, fig. 15; and Palæontology of New York, vol. vii, 1888, pl. 14, fig. 2.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 13, fig. 16; and Palæontology of New York, vol. vii, 1888, pl. 14, fig. 3.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 14, figs. 4, 5, 6.
(The originals of Conrad's *Asaphus ? acantholeurus.*)
Corniferous limestone. "Near Schoharie in limestone with Odontocephalus (Onondaga limestone)."

Palæontology of New York, vol. vii, 1888, pl. 15, figs. 1, 2, 3.
Corniferous limestone. Near Clarksville, N. Y.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 15, fig. 14.
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Dalmanites coronatus, Hall, 1861.

Descr. New Species Fossils, etc. p. 58.

Palæontology of New York, vol. vii, 1888, pl. 11b, fig. 14.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Family CERAURIDÆ.

Genus CERAURUS, Green. 1832.

Ceraurus pleurexanthemus, Green. 1832.

Monograph of the Trilobites of North America, p. 84, pl. 1, fig. **10**; original of cast **No. 33**.
Trenton limestone. Newport, N. Y.
The Albany Institute donor.

Ceraurus ? sp. indet, Hall. 1847.

Palæontology of New York, vol. i, p. 25, pl. iv bis, fig. **20**.
Chazy limestone. Chazy, N. Y.
Geological Survey collection.

Family ACIDASPIDÆ.

Genus CERATOCEPHALA, Warder. 1838.

Acidaspis sp. Hall. 1888.

Palæontology of New York, vol. vii, 1888, pl. 16b, fig. **14**.
Corniferous limestone. Cayuga, Ontario.

Sub-genus ACIDASPIS, Murchison. 1839.

Acidaspis tuberculata, Conrad (sp.) 1840.

Ann. Rept. Pal. Dept., N. Y., p. 205.

Palæontology of New York, vol. iii, 1859, pl. 79, figs. 1, 1a.
Lower Helderberg group. Near Clarksville, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 79, figs. 3, 5.
Lower Helderberg group. Schoharie county, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 79, fig. 8a.
Lower Helderberg group. Schoharie county, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 79, fig. 12.
Lower Helderberg group. Schoharie county, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1959, pl. 79, fig. 13.
Lower Helderberg group. Schoharie county, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 79, fig. 14.
Lower Helderberg group. Near Clarksville, N. Y.
J. Gebhard purchase.

Acidaspis Trentonensis, Hall. 1847.

("Acidaspis crosotus Locke." J. Gebhard.)

Ninth Annual Report New York State Cabinet of Natural History, pp. 45–47. 1856. Not figured.
Trenton limestone, Cape Vincent, N. Y.
Moses Eames donor.

Sub-genus ODONTOPLEURA, Murchison. 1839.

Acidaspis callicera, Hall. 1888.

*Palæontology of New York, vol. vii, 1888, p. 69, pl. 16b, figs. **1, 2**.
Corniferous limestone. Camillus, N. Y.

Palæontology of New York, vol. vii, 1888, pl. 16b, figs. **3, 4, 5, 6, 7**.
Corniferous limestone. Cayuga, Ontario.
Collected by C. D. Walcott, 1878.

Palæontology of New York, vol. vii, 1888, pl. 16b, fig. **9**.
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16b, fig. **13**.
Schoharie grit. Near Clarksville, N. Y.
J. M. Clarke purchase.

Sub-genus DICRANURUS, Conrad. 1841.

Acidaspis hamatus, Conrad (sp.). 1841.

Ann. Rep. Pal. Dept. N. Y., p. 48.

Palæontology of New York, vol. iii, pl. 79, fig. 16.
Lower Helderberg group. Schoharie county, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 79, fig. 17.
Lower Helderberg group. Schoharie county, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 79, fig. 19.
Lower Helderberg group. Albany county, N. Y.

Palæontology of New York, vol. iii, 1859, pl. 79, fig. 19a.
Lower Helderberg group. Schoharie county, N. Y.
J. Gebhard purchase.

Sub-genus ANCYROPYGE, Clarke, 1891.

Acidaspis Romingeri, Hall. 1888.

*Palæontology of New York, vol. vii, 1888, p. 71, pl. 16b, figs. **15, 16, 17, 18**.
Hamilton group. Little Traverse Bay, Michigan.

Family LICHADÆ.

Genus LICHAS, Dalman. 1826.

Sub-genus CONOLICHAS, Dames. 1877.

Lichas pustulosus, Hall. 1859.

Palæontology of New York, vol. iii, 1859, p. 366, pl. 77, figs. **9, 10**.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 77, fig. **11**.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebbard purchase.

Palæontology of New York, vol. iii, 1859, pl. 78, fig. **2**.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 78, fig. **3**.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 78, fig. **4** (mutilated by having the terminal lobe artifically divided).
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 78, fig. **6**.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

* Palæontology of New York, vol. vii, 1888, pl. 19, fig. 8.
Lower Helderberg group (Shaly limestone). Near Clarksville, N. Y.

Palæontology of New York, vol. vii, 1888, pl. 19, fig. 10.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19, fig. 11.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Conolichas? sp., Hall. 1888.

Palæontology of New York, vol. iii, pl. 78, fig. **7** (*Lichas pustulosus*, Hall); and Palæontology of New York, vol. vii, pl. 19, fig. **9**.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

(?) *Lichas Bigsbyi*, Hall. 1859.

Palæontology of New York, vol. iii, p. 364.

* Palæontology of New York, vol. vii, 1888, pl. 19a, fig. 1.
Lower Helderberg group. Schoharie, N. Y.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 19, fig. 12.
Lower Helderberg group. Schoharie, N. Y.
J. Gebhard purchase.

(?) *Lichas Eriopis*, Hall. 1863.

Sixteenth Rept. N. Y. State Cab. Nat. Hist., p. 226.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 19, figs. **4**, **5**, **6**, **7**; and Palæontology of New York, vol. vii, 1888, pl. 19a, figs. **2**, **3**, **4**, **5**.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19a, fig. 7.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 19a, fig. 8.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 19, fig. 10; and Palæontology of New York, vol. vii, 1888, pl. 19a, fig. 9.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 19, fig. 12 [*Acidaspis* (*Terataspis*) *sp.*]; and Palæontology of New York, vol. vii, 1888, pl. 19a, fig. 11.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19a, figs. 13, 15, 16.
Corniferous limestone (drift). Canandaigua, N. Y.
Collected by J. M. Clarke, 1885.

? *Lichas hispidus*, Hall. 1888.

Palæontology of New York, vol. vii, p. 77.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 19, figs. 8, 9; and Palæontology of New York, vol. vii, 1888, pl. 19a, figs. 14, 17.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19a, fig. 18.
Corniferous limestone. Le Roy, N. Y.
Collected by C. D. Walcott and C. Van Deloo, 1877.

Sub-genus CERATOLICHAS, Hall. 1888.

Lichas gryps, Hall. 1888.

Palæontology of New York, vol. vii, p. 84.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 19, fig. 1; and Palæontology of New York, vol. vii, 1888, pl. 19b, figs. 7, 8.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19b, figs. 9, 10, 11.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 19b, figs. **12, 12a, 13.**
Corniferous limestone. Canandaigua, N. Y.
Collected by J. M. Clarke, 1886.

Lichas dracon, Hall. 1888.

Palæontology of New York, vol. vii, pl. 85.

Illustrations of Devonian Fossils, pl. 19, figs. **2, 3**; and Palæontology of New York, vol. vii, 1888, pl. 19b, figs. **14, 15.**
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, pl. 19b, figs. **16, 17.**
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19b, figs. **18, 18a.**
Corniferous, limestone. Le Roy, N. Y.
Collected by J. M. Clarke, 1886.

Sub-genus ARGES, Goldfuss. 1839.

Lichas contusus, Hall. 1888.

Palæontology of New York, vol. viii, 1888, p. 83, pl. 19b, fig. **3.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 19b, figs. **4, 5, 6.**
Corniferous limestone. Near Clarksville, N. Y.
Collected by J. W. Hall, 1877.

Sub-genus TERATASPIS, Hall. 1863.

Lichas grandis, Hall. 1861.

Descr. New Species Foss., p. 82.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 17, figs. **1 2**; and Palæontology of New York, vol. vii, 1888, pl. 17, figs. **2, 3.**
Schoharie grit. Knox, N. Y.
Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 17, figs. **5, 4**; and Palæontology of New York, vol. vii, pl. 17, figs. **4, 5.**
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19, fig. 1.
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1862.

Palæontology of New York, vol. vii, 1888, pl. 19, fig. 2.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 18, fig. 4; and Palæontology of New York, vol. vii, 1888, pl. 19, fig. 5.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19, fig. 6.
Schoharie grit. Knox, N. Y.
Collected by C. Van Deloo, 1862.

Palæontology of New York, vol. vii, 1888, pl. 19, fig. 7.
Schoharie grit. Thompson's Lake, N. Y.
Collected by C. Van Deloo, 1862.

Sub-genus **DICRANOGMUS**, Corda. 1847.

Lichas ptyonurus, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 86, pl. 19b, fig. 19.
Niagara group (Coralline limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19b, fig. 20.
Niagara group (Coralline limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19b, fig. 21.
Niagara group (Coralline limestone). Schoharie, N. Y.
J. Gebhard purchase.

Family PROETIDÆ.

Genus **PROETUS**, Steininger. 1831.

Proetus Corycœus, Conrad (sp.) 1842.

Journ. Acad. Nat. Sci., vol. 8, p. 277.

Palæontology of New York, vol. ii, pl. 67, fig. 15.
Niagara group. Lockport, N. Y.

Proetus protuberans, Hall. 1859.

Palæontology of New York, vol. iii, 1859, p. 351, pl. 73, fig. 5.
Lower Helderberg group. Schoharie, N. Y.
J. Gebhard purchase.

Proetus angustifrons, Hall. 1861.

Descr. New Species Fossils, p. 70.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 1.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 2.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 3.
Schoharie grit. Near Clarksville, N. Y.
J. M. Clarke purchase.

Proetus Conradi, Hall. 1861.

Descr. New Species Fossils, p. 69.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 4.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Proetus Hesione, Hall. 1861.

Descr. New Species Fossils, p. 70.

* Illustrations of Devonian Fossils, 1876; Crustacea, pl. 20, figs. 15, 16; and Palæontology of New York, vol. vii, 1888, pl. 20, figs. 15, 16.
Schoharie grit. Schoharie, N. Y.

Proetus sp., Hall, 1888.

Palæontology of New York, vol. vii, 1888, p. 94, pl. 22, fig. 5.
Schoharie grit, Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 6.
Schoharie grit. Knox, N. Y.
Collected by C. Van Deloo, 1862,

Proetus curvimarginatus, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 94, pl. 22, fig. **13**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, figs. **14**, **15**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, pl. 22, fig. **16**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. **17**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, figs. **18**, **19**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Proetus latimarginatus, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 97, pl. 22, fig. **7**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. **8**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. **9**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. **10**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. **11**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. **12**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Proetus clarus, Hall. 1861.

Descr. New Species Fossils, p. 71.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 28.
Corniferous limestone. Decewville, Ontario.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 29.
Corniferous limestone. Lime Rock, near Le Roy, N. Y.
Collected by J. M. Clarke, 1888.

Proetus folliceps, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 101, pl. 23, figs. **3**, **4**, **8**.
Corniferous limestone. Near Le Roy, N. Y.
Collected by C. D. Walcott and C. Van Deloo, 1877.

Palæontology of New York, vol. vii, 1888, pl. 23, figs. **6**, **7**.
Corniferous limestone (drift). Ann Harbor, Michigan.
Donated by C. Rominger.

Proetus delphinulus, Hall. 1888.

*Palæontology of New York, vol. vii, 1888, p. 111, pl. 23, figs. **1**, **2**; pl. 25, fig. **6**.
Corniferous limestone. Port Colborne, Ontario.

Proetus canaliculatus, Hall. 1861.

Descr. New Species Fossils, p. 73.

Palæontology of New York, vol. vii, 1888, pl. 23, figs. 10, 11.
Corniferous limestone. Falls of the Ohio.

Proetus crassimarginatus, Hall. 1843.

Geol. N. Y.; Rept. Fourth Dist., p. 172, fig. 5.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 20, fig. 5; and Palæontology of New York, vol. vii, 1888, pl. 20, fig. 6.
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 20, figs. 8, 9; and Palæontology of New York, vol. vii, 1888, pl. 20, figs. 7, 8.
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 20, figs. 23, 24; and Palæontology of New York, vol. vii, 1888, pl. 20, figs. 23, 24.
Coniferous limestone. Clarence, N. Y.
Collected by C. A. White, R. P. Whitfield and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 20, fig. 27; and Palæontology of New York, vol. vii, 1888, pl. 20, fig. 27.
Corniferous limestone. Cayuga, Ontario.
Collected by J. De Cew, 1866.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 20.
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1862.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 21.
Schoharie grit. Near Clarksville, N. Y.
Collected by C Van Deloo, 1862.

Palæontology of New York, vol. vii, 1888, pl. 22. fig. 23.
Corniferous limestone. Falls of the Ohio.

Proetus ? planimarginatus, Meek. 1871.

Proc. Acad. Nat. Sci. Phil., p. 89.

* Palæontology of New York, vol. vii, 1888, pl. 23, fig. **21**.
Corniferous limestone. Sylvania, Ohio.

Proetus stenopyge, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 110, pl. 22, fig. **27**.
Corniferous limestone. Phelps, N. Y.
Collected by J. M. Clarke, 1886.

Proetus ovifrons, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 110, pl. 22, fig. **31**.
Corniferous limestone (drift). Canandaigua, N. Y.
Collected by J. M. Clarke, 1886.

Palæontology of New York, vol. vii, 1888, p. 22, fig. **32**.
Corniferous limestone (drift). Canandaigua, N. Y.
Collected by J. M. Clarke, 1886.

Proetus microgemma, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 109, pl. 22, fig. **33**.
Corniferous limestone. Phelps, N. Y.
Collected by J. M. Clarke, 1886.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 34.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Proetus Rowi, Green (sp.). 1838.

Amer. Journ. Sci., vol. 33, p. 406.

* Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. 4; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. 4.
Hamilton group. Otsego county, N. Y.

* Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. 5; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. 5.
Hamilton group. Otsego county, N. Y.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. 24; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. 24.
Tully limestone. Near Ovid, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 23, fig. 20.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 23, fig. 22.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 23, fig. 23.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 23, fig. 24.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

* Palæontology of New York, vol. vii, 1888, pl. 23, fig. 25.
Hamilton group (drift). Ann Arbor, Michigan.

Palæontology of New York, vol. vii, 1888, pl. 23, fig. 26.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, figs. 25, 26; and Palæontology of New York, vol. vii, 1888, pl. 21, figs. 25, 26; pl. 23, fig. 27.
Tully linestone. Near Ovid, N. Y.
J. Gebhard purchase.

(*) Palæontology of New York, vol. vii. 1888, pl. 23, fig. 29.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Proetus Haldemani, Hall. 1861.

Descr. New Species Fossils, p. 74.

* Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, figs. 7, 8; and Palæontology of New York, vol. vii, 1888, pl. 21, figs. 7, 8; pl. 23, fig. 15.
Hamilton group. Pennsylvania.

* Palæontology of New York, vol. vii, 1888, pl. 23, fig. 13.
Devonian. Rescue Hill, Eureka District, Nevada.

Proetus macrocephalus, Hall. 1861.

Descr. New Species Fossils, p. 77.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. 10; Palæontology of New York, vol. vii, 1888, pl. 21, fig. 10.
Hamilton group. Canandaigua Lake, N. Y.
Collected by R. P. Whitfield and C. Van Deloo, 1858.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. 13; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. 13.
Hamilton group. York, N. Y.
Collected by J. W. Hall and C. Van Deloo, 1866.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. 14; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. 14.
Hamilton group. Canandaigua Lake, N. Y.
Collected by R. P. Whitfield and J. W. Hall, 1858.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig 17; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. 17.
Hamilton group. Canandaigua Lake, N. Y.
Collected by R. P. Whitfield and J. W. Hall, 1858.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. **18**; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. **18.**
Hamilton group. Locality?

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. **19**; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. **19.**
Hamilton group. North Bristol, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Palæontology of New York, vol. vii, 1888, pl. 23, fig. 30.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 23, fig. 31.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Proetus Prouti, Shumard. 1863.

Trans. St. Louis Acad. Sci., vol. ii, No. 1, p. 110.

(*Proetus Davenportensis*, Barris, 1878, Proc. Davenport Acad. Nat. Sci., vol. ii, p. 287.)
* Palæontology of New York, vol. vii, 1888, pl. 23, figs. **16, 17.**
Hamilton group. Smith's Quarry, Davenport, Iowa.

* Palæontology of New York, vol. vii, 1888, pl. 23, fig. 18
Hamilton group. Cook's Quarry, Davenport, Iowa.

Proetus Phocion, Billings. 1874.

Pal. Foss. Canada, vol. ii, p. 63.

* Palæontology of New York, vol. vii, 1888, pl. 25, fig. **9.**
Hamilton group. Indian Cove, Gaspé, Quebec.

* Palæontology of New York, vol. vii, 1888, pl. 25, fig. **10.**
Hamilton group. Indian Cove, Gaspé, Quebec.

Proetus Nevadæ, Hall. 1888.

* Palæontology of New York, vol. vii, 1888, p. 129, pl. 23, fig. **19.**
Devonian. Comb's Peak, Eureka District, Nevada.

Proetus Missouriensis, Shumard. 1855.

Geol. Rept. Miss., p. 196.

(*Proetus auriculatus*, Hall, 1861. Descr. New Species Fossils, p. 79.)
Palæontology of New York, vol. vii, 1888, pl. 23, fig. **32.**
Waverly group. Licking county, Ohio.

Genus CORDANIA, Clarke. 1893.

Phaëthonides cyclurus, Hall. 1888.

Palæontology of New York, vol. vii, p. 137, pl. 24, figs. **26, 26a.**
Lower Helderberg group (Shaly limestone). Near Clarksville, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **27**.
Lower Helderberg group (Shaly limestone). Near Clarksville, N.Y.
J. M. Clarke purchase.

Palæntology of New York, vol. vii, 1888, pl. 24, fig. **28.**
Lower Helderberg group (Shaly limestone). Near Clarksville, N.Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 25, fig. **11.**
Lower Helderberg group (Shaly limestone). Near Clarksville, N.Y.
J. M. Clarke purchase.

Phaëthonides arenicolus, Hall. 1888.

* Palæontology of New York, vol. vii, 1888, p. 134, pl. 25, fig. **12.**
Schoharie grit. Schoharie, N. Y.

Phaëthonides varicella, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 135, pl. 24, figs. **29, 29a.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, figs. **30, 30a**.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **31**.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Phaëthonides gemmæus, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 136, pl. 24, fig. **32**.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **33.**
Hamilton group. Eighteen-mile Creek, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **34.**
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **35.**
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **36.**
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Phaëthonides Macrobius, Billings (sp.). 1863.

Proc. Portland Soc. Nat. Hist., p. 123.

Palæontology of New York, vol. vii, 1888, pl. 24, figs. 24, 24a.
Lower Helderberg group. Square Lake, Maine.
J. M. Clarke purchase.

Genus CYPHASPIS, Burmeister. 1843.

Cyphaspis cœlebs, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 151, pl. 24, fig. **1.**
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Cyphaspis minuscula, Hall (sp.). 1876.

Illustr. Devon. Fossils. Expl. pl. 20, fig. 17.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. 7.
Schoharie grit. Near Clarksville, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, figs. 8, 8a.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, figs. 9, 10.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. 11.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. 12.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Cyphaspis stephanophora, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 142, pl. 24, figs. **2, 3.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **4.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **5.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York. vol. vii, 1888, pl. 24, figs. **6, 6a.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Cyphaspis diadema, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 141, pl. 24, fig. **13.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Cyphaspis hybrida, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 144, pl. 24, fig. **14.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Cyphaspis craspedota, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 148, pl. 24, figs. **15 16, 17.**
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, figs. **18, 19.**
Hamilton group. Centerfield, N. Y.

J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **20.**
Hamilton group. Centerfield, N. Y.

J. M. Clarke purchase.

Cyphaspis ornata, Hall. 1876.

Illustr. Dev. Foss. Exp., pl. 21, fig. 1.

Palæontology of New York, vol. vii, 1888, pl. 24, figs. 21, 21a.
Hamilton group. Canandaigua, N. Y.

J. M. Clarke purchase.

Cyphaspis ornata, var. baccata, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 146, pl. 24, figs. **22, 22a.**
Hamilton group. Canandaigua, N. Y.

J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **23.**
Hamilton group. Canandaigua, N. Y.

J. M. Clarke purchase.

MEROSTOMATA.

Family EURYPTERIDÆ.

Genus EURYPTERUS, DeKay, 1825.

Eurypterus prominens, Hall. 1888.

(*) Palæontology of New York, vol. vii, 1888, p. 157, pl. 27, figs. **3, 4.**
Clinton group. Northern part of Cayuga county, N. Y.

Eurypterus remipes, DeKay. 1825.

Ann. Lyc. Nat. Hist. N. Y., p. 375.

Palæontology of New York, vol. iii, 1859, pl. 80a, fig. 11.
Waterlime formation. Waterville, N. Y.
J. Gebhard purchase.

Eurypterus lacustris, Harlan. 1834.

Trans. Geol. Soc. Penna., vol. i, p. 98.

Palæontology of New York, vol. iii, 1859, pl. 81, fig. 3.
Waterlime formation. Williamsville, N. Y.
J. Gebhard purchase.

Eurypterus pachycheirus, Hall. 1859.

Palæontology of New York, vol. iii, 1859, p. 412,* pl. 82,* figs. **1, 1a.**
Waterlime formation. Near Buffalo, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 82,* fig. **3.**
Waterlime formation. Near Buffalo, N. Y.
J. Gebhard purchase.

Eurypterus DeKayi, Hall. 1859.

Palæontology of New York, vol. iii, 1859, p. 411,* pl. 82, fig. **1.**
Waterlime formation. Black Rock, N. Y.
J. Gebhard purchase.

Eurypterus Beecheri, Hall. 1884.

Second Geol. Surv. Penna. PPP., p. 30.

* Palæontology of New York, vol. vii, 1888, pl. 27, fig. **5.**
Chemung group. Warren, Pennsylvania.

Eurypterus approximatus, Hall. 1888.

(*) Palæontology of New York, vol. vii, 1888, expl. pl. 27, fig. **6.**
Waverly group. Near Warren, Pennsylvania.

Genus STYLONURUS, Page. 1856.

Stylonurus excelsior, Hall. 1883.

Thirty-sixth Rept. N. Y. State Mus. Nat. Hist., p. 77.

(*) Palæontology of New York, vol. ii, 1888, pl. 26, fig. **1.**
Catskill group. Andes, N. Y.

(*) Palæontology of New York, vol. vii, 1888, pl. 26a, figs. **1, 2, 3** (*Dolichocephala Lacoana*, Claypole, 1883, Proc. Amer. Philos. Soc. vol. xxi, p. 236).
Catskill group. Meshoppen, Pennsylvania.

Stylonurus? (Echinocaris?) Wrightianus, Dawson.

Quart. Journ. Geol. Soc. vol. xxxvii, p. 301.

(*) Palæontology of New York, vol. vii, 1888, pl. 27, figs. **7, 8, 9.**
Portage group. Italy, N. Y.

PHYLLOCARIDA.

Family CERATIOCARIDÆ.

Genus ECHINOCARIS, Whitfield. 1880.

Æchinocaris punctata, Hall. 1863.

Sixteenth Rept. N. Y. State Cab. Nat. Hist., p. 74.

Palæontology of New York, vol. vii, 1888, pl. 27, fig. 10; pl. 28, fig. 4.
Hamilton group. Canandaigua Lake, N. Y.
Collected by J. M. Clarke, 1886.

Palæontology of New York, vol. vii, 1888, pl. 28, figs. 1, 2; pl. 29, fig. 6.
Hamilton group. Fabius, N. Y.
Collected by G. B. Simpson, 1863.

Palæontology of New York, vol. vii, 1888, pl. 28, fig. 3.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1874.

Palæontology of New York, vol. vii, 1888, pl. 28, fig. 5.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1874.

Sixteenth Report on New York State Cabinet of Natural History, 1863, pl. 1, figs. 1, 2; Illustrations of Devonian Fossils, 1876; Crustacea, pl, 23, figs. 4, 5; and Palæontology of New York, vol. vii, 1888, pl. 28, figs. 6, 7.
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Palæontology of New York, vol. vii, 1888, pl. 29, figs. 1, 2.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1874.

Palæontology of New York, vol. vii, 1888, pl. 29, fig. 3.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1874.

Palæontology of New York, vol. vii, 1888, pl. 29, fig. 4.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1874.

Palæontology of New York, vol. vii, 1888, pl. 29, fig. 5.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1874.

Palæontology of New York, vol. vii, 1888, pl. 29, fig. 7.
Hamilton group. Cayuga Lake, N. Y.
Collected by H. H. Smith, 1871.

Sixteenth Report on New York State Cabinet of Natural History, 1863, pl. 1, fig. **8**; Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. **7**; and Palæontology of New York, vol. vii, 1888, pl. 29, fig. **8**.
Hamilton group. Cayuga Lake, N. Y.
Collected by C. A. White, 1860.

Mandibles of Phyllocarida (Echinocaris punctata).

Palæontology of New York, vol. vii, 1888, pl. 30. fig. **13**.
Hamilton group. Pratt's Falls. N. Y.
Collected by J. W. Hall, 1875.

Palæontology of New York, vol. vii, 1888, pl. 30, fig **14**.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith, 1873.

Palæontology of New York, vol. vii, 1888, pl. 30, fig. **15**.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1873.

Palæontology of New York, vol. vii. 1888, pl. 30, fig. **16**.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1873.

Palæontology of New York, vol. vii, 1888, pl. 30, fig. **17**.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1873.

Palæontology of New York, vol. vii. 1888, pl. 30, fig. **18.**
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1873.

Palæontology of New York, vol. vii, 1888, pl. 30, fig. **19.**
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1873.

[?] *Ceratiocaris longicauda,* Hall. 1861.

Sixteenth Report on New York State Cabinet of Natural History, 1861, p. 73, pl. 1, fig. **7** (not figs. 4, 5, 6 = *Coleolus* or *Orthoceras*); and Palæontology of New York, vol. vii, 1888, pl. 31, fig. **1.**
Genesee shales. Bristol Center, N. Y.
Collected by R. P. Whitfield and C. Van Deloo, 1862.

Echinocaris Whitfieldi, Clarke. 1885.

Bull. No. 16. U. S. Geol. Surv. p. 45.

Palæontology of New York, vol. vii, 1888, pl. 29, fig. **20.**
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

* Palæontology of New York, vol. vii, 1888, pl. 29, fig. **21.**
Naples beds. Naples, N. Y.

[?] *Ceratiocaris Beecheri,* Clarke. 1885.

Palæontology of New York, vol. vii, 1888, pl. 30, fig. **3.**
Naples beds. Sonyea, N. Y.

Echinocaris condylepis, Hall. 1880.

Palæontology of New York, vol. vii, 1888, p. 173, pl. 29, figs. **14, 15.**
Chemung group. Belmont, N. Y.
Collected by Andrew Sherwood, 1871.

Palæontology of New York, vol. vii, 1888, pl. 29, figs. **16, 17.**
Chemung group. Belmont, N. Y.
Collected by Andrew Sherwood, 1871.

Echinocaris socialis, Beecher. 1884.

Second Geol. Surv. Penna., PPP, p. 10.

* Palæontology of New York, vol. vii, 1888, pl. 30, fig. **6.**
Chemung group. Warren, Pennsylvania.

Palæontology of New York, vol. vii, 1888, pl. 30, fig. 7.
Chemung group. Warren, Pennsylvania.
F. A. Randall purchase

* Palæontology of New York, vol. vii, 1888, pl. 30, fig. **8.**
Chemung group. Warren Pennsylvania.

Palæontology of New York, vol. vii, 1888. pl. 30, fig. 10.
Chemung group. Warren, Pennsylvania.
F. A. Randall purchase.

Echinocaris multinodosa, Whitfield. 1880.

Amer. Journ. Science, vol. xix, p. 38.

* Palæontology of New York, vol. vii, 1888, pl. 29, fig. **18.**
Erie shale. Paine's Creek, Ohio.

* Palæontology of New York, vol. vii, 1888, pl. 29, fig. **19.**
Erie shale. Paine's Creek, Ohio.

Echinocaris pustulosa, Whitfield. 1880.

Amer. Journ. Science, vol. xix, p. 38.

* Palæontology of New York, vol. vii, 1888, pl. 29, figs. **9, 10.**
Erie shale. Paine's Creek, Ohio.

Echinocaris sublævis, Whitfield. 1880.

Amer. Journ. Science, vol. xix, p. 36.

* Palæontology of New York, vol. vii, 1888, pl. 29, figs. **11, 12.**
Erie shale. Paine's Creek, Ohio.

Genus ELYMOCARIS, Beecher. 1884.

Elymocaris capsella, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 181, pl. 31, fig. **4.**
Hamilton group. Canandaigua lake, N. Y.
J. M. Clarke purchase.

Elymocaris siliqua, Beecher. 1884.

Second Geol. Surv. Penna. PPP, p. 13.

* Palæontology of New York, vol. vii, 1888, pl. 31, fig. **5.**
Chemung group. Warren, Pennsylvania.

* Palæontology of New York, vol. vii, 1888, pl. 31, fig. **6.**
Chemung group. Warren, Pennsylvania.

Genus TROPIDOCARIS, Beecher. 1884.

Tropicodaris Hamiltoniæ. Hall, 1888.

Palæontology of New York, vii, 1888, expl. pl. 30, figs. **24, 25.**
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Tropidocaris interrupta, Beecher. 1884.

Second Geol. Surv. Penna. PPP, p. 18.

* Palæontology of New York, vol. vii, 1888, pl. 31, fig. **13.**
Chemung group. Warren, Pennsylvania.

Tropidocaris bicarinata, Beecher. 1883.

Second Geol. Surv. Penna. PPP, p. 16.

* Palæontology of New York, vol. vii, 1888, pl. 31, figs. **7, 9.**
Chemung group. Warren, Pennsylvania.

Palæontology of New York, vol. vii, 1888, pl. 31, figs. 8, 10.
Chemung group. Warren, Pennsylvania.
F. A. Randall purchase.

* Palæontology of New York, vol. vii, 1888, pl. 31, fig. **11.**
Chemung group. Warren, Pennsylvania.

Tropidocaris alternata, Beecher. 1884.

Second Geol. Surv. Penna. PPP. p. 19.

* Palæontology of New York, vol. vii, 1888, pl. 31, fig. **14.**
Waverly group. Warren, Pennsylvania.

* Palæontology of New York, vol. vii, 1888, pl. 31, fig. **15.**
Waverly group. Warren, Pennsylvania.

Family RHINOCARIDÆ.

Genus RHINOCARIS, Clarke. 1888.

Rhinocaris columbina, Clarke. 1888.

Palæontology of New York, vol. vii, 1888, p. 196, pl. 31, figs. **16, 17.**
Hamilton group. Canandaigua Lake, N. Y.
Collected by J. M. Clarke, 1886.

Palæontology of New York, vol. vii, 1888, pl. 31, fig. **18.**
Hamilton group. Cayuga Lake, N. Y.
Collected by H. H. Smith, 1871.

Palæontology of New York, vol. vii, 1888, pl. 31, fig. **19.**
Hamilton group. Cayuga Lake, N. Y.
Collected by H. H. Smith, 1871.

Palæontology of New York, vol. vii, 1888, pl. 31, fig. **20.**
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Rhinocaris scaphoptera, Clarke. 1888.

Palæontology of New York, vol. vii, 1888, p. 197, pl. 31, figs. **22, 23.**
Hamilton group. Canandaigua Lake, N. Y.
Collected by J. M. Clarke, 1886.

Genus **MESOTHYRA**, Hall. 1888.

Mesothyra Veneris, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 193, pl. 33, fig. **3.**
Marcellus shale. East Bloomfield, N. Y.
J. M. Clarke purchase.

Mesothyra Neptuni, Hall. 1863.

Sixteenth Report on New York State Cabinet of Natural History, 1863, p. 75, pl. 1, fig. **9**; Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. **6**; and Palæontology of New York, vol. vii, 1888, pl. 32, fig. **7**; pl. 33, fig. **1.**
Hamilton group. Plainfield, N. Y.
J. Gebhard purchase.

Mesothyra spumæa, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 93, pl. 32, figs. **8, 9.**
Hamilton group. Delphi, N. Y.
Collected by J. W. Hall and G. B. Simpson, 1875.

Palæontology of New York, vol. vii, 1888, pl. 33, fig. **2.**
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1874.

Mesothyra Oceani, Hall. 1888.

Pal. N. Y., vol. vii, p. 187.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. **1**; Palæontology of New York, vol. vii, 1888, pl. 32, fig. **3**; pl. 33, fig. **5.**
Portage group. Ithaca, N. Y.
Collected by J. W. Hall and G. B. Simpson, 1870.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. **2**; and Palæontology of New York, vol. vii, 1888, pl. 34, fig. **2**.

Portage group. Ithaca, N. Y.

Collected by J. W. Hall and G. B. Simpson, 1870.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. **3**; and Palæontology of New York, vol. vii, 1888, pl. 34, fig. **1**.

Portage group. Ithaca, N. Y.

Collected by J. W. Hall and G. B. Simpson, 1870.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. **4**; and Palæontology of New York, vol. vii, 1888, pl. 32, fig. **5**; pl. 34, fig. **4**.

Portage group. Ithaca, N. Y.

Collected by J. W. Hall and G. B. Simpson, 1870.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. **5**; and Palæontology of New York, vol. vii, 1888, pl. 34, fig. **3**.

Portage group. Ithaca, N. Y.

Collected by J. W. Hall and G. B. Simpson, 1870.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. **1**; and Palæontology of New York, vol. vii, 1888, pl. 33, fig. **6**.

Portage group. Ithaca, N. Y.

Collected by J. W. Hall and G. B. Simpson, 1870.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23; fig. **2**; and Palæontology of New York, vol. vii, 1888, pl. 33, fig. **7**.

Portage group. Ithaca, N. Y.

Collected by J. W. Hall and G. B. Simpson, 1870.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. **3**; and Palæontology of New York, vol. vii, 1888, pl. 34, fig. **5**.

Portage group. Ithaca, N. Y.

Collected by J. W. Hall and G. B. Simpson, 1870.

Palæontology of New York, vol. vii, 1888, pl. 32, figs. 1, 2, 4, 6; pl. 33, fig. 4.

Portage group. Ithaca, N. Y.

Collected by J. W. Hall and G. B. Simpson, 1870.

Family DISCINOCARIDÆ.

[?] Genus **SPATHIOCARIS**, Clarke. 1882.

Spathiocaris Emersoni, Clarke. 1882.

Amer. Journ. Science, 3d Ser., vol. 23, p. 447.

Palæontology of New York, vol. vii, 1888; pl. 35, fig. 12.
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. 13.
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. 14.
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. 15.
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. 16.
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. 17.
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. 18.
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. 19.
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

(?) Genus **DIPTEROCARIS**, Clarke. 1883.

Dipterocaris pes-cervæ, Clarke. 1883.

Amer. Journ. Science, 3d ser., vol. 25, p. 123.

Palæontology of New York, vol. vii, 1888, pl. 35, figs, 20, 21.
Chemung group. Dansville, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, figs. 22, 23.
Naples beds. Naples, N. Y.

J. M. Clarke purchase.

Dipterocaris pennæ-Dædali, Clarke. 1883.

Amer. Journ. Science, 3d ser., vol. xxv, p. 122.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. **24**.
Portage group. Canadice, N. Y.

J. M. Clarke purchase.

Dipterocaris Procne, Clarke. 1883.

Amer. Journ. Science, 3d ser., vol. xxv, p. 122.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. **25**.
Portage group. Canadice, N. Y.

J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, figs. **26**, **27**.
Chemung group. Haskinsville, N. Y.

J. M. Clarke purchase.

PHYLLOPODA.

Family **LIMNIADIADÆ.**

Genus **ESTHERIA**, Ruppell.

Æstheria pulex, Clarke. 1882.

Amer. Journ. Science, vol. 23, p. 476.

Palæontology of New York, vol. vii, 1888, pl. 35, figs. **10, 11.**
Hamilton group. Hopewell, N. Y.
J. M. Clarke purchase.

Genus **SCHIZODISCUS**, Clarke.

Schizodiscus capsa, Clarke. 1888.

Palæontology of New York, vol. vii, 1888, p. 209, pl. 35, figs. **1, 2.**
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, figs. **3, 4.**
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. **5.**
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. **6.**
Hamilton group. Centerfield, N. Y.
J. M. Clark purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, figs. **7, 8.**
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. **9.**
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

DECAPODA.

Family CARIDIDÆ.

Genus PALÆOPALÆMON, Whitfield. 1880.

Palæopalæmon Newberryi, Whitfield. 1880.

Amer. Jour. Science, vol. 19, p. 41.

*Palæontology of New York, vol. vii, 1888, pl. 30, figs. **20, 21, 22, 23.**

Erie shale. Le Roy, Ohio.

Summary.

Crustacea.

Total original specimens	248
Total illustrated specimens	496
Total casts of original specimens	50
Total figures of these specimens	742

Record of Localities of Extra Limital Geological and Palæontological Collections of the New York State Museum.

[Specimens marked with round orange-colored tickets.]

No. 157. Clinton group. Hamilton, Ontario, Canada. C. D. Walcott collector. 1878.

No. 180. Niagara shale. Waldron, Shelby county, Indiana. C. D. Walcott and C. Van Deloo, collectors. 1878.

No. 181. Niagara limestone. Charlestown, Clark county, Indiana. C. D. Walcott, collector. 1878.

No. 182. Niagara limestone. Flat Rock creek, Shelby county, Indiana. C. D. Walcott, collector. 1878.

No. 183. Niagara limestone. Hamilton, Ontario, Canada. C. D. Walcott, collector. 1878.

No. 255. Sandstone, =Schoharie grit. Pendleton, Madison county, Indiana. C. D. Walcott and C. Van Deloo, collectors. 1878.

No. 278. Corniferous limestone. Charlestown, Clarke county, Indiana. C. D. Walcott and C. Van Deloo, collectors.

No. 278a. Corniferous limestone. Lexington, Scott county, Indiana. C. D. Walcott and C. Van Deloo, collectors.

No. 279. Corniferous limestone. Falls of the Ohio. From Sidney Lyon.

No. 279a. Corniferous limestone. Falls of the Ohio. C. D. Walcott, collector. 1877.

No. 280. Corniferous limestone. South Walpole, Ontario, Canada, 4th Con. Lot 14. C. D. Walcott, collector. 1878.

No. 281. Corniferous limestone. North Walpole, Ontario, Canada. 13 Con. Lot 5. C. D. Walcott, collector. 1878.

No. 282. Corniferous limestone. South Cayuga. 4th Con. Lots 30 and 32. C. D. Walcott, collector. 1878.

No. 283. Corniferous limestone. Pt. Colborne and Wainfleet, Ontario, Canada. 1 and 2 Con. C. D. Walcott, collector. 1878.

No. 284. Corniferous limestone. Kelly's Island and on Pt. Marble Head, Ohio. C. D. Walcott, collector. 1878.

No. 300. Hamilton group. Falls of the Ohio and southern Indiana. Sidney Lyon.

No. 301. Hamilton group. Lexington, Scott county, Indiana. C. D Walcott and C. Van Deloo, collectors. 1878.

No. 324. Hamilton group. Just beneath the Black slate (Genesee). Lexington, Scott county, Indiana. C. D. Walcott, collector.

No. 324a. Hamilton group? Beneath the Waterlime. Lexington, Scott county, Indiana. C. D. Walcott, collector.

No. 326. New Albany Black slate=(Genesee slate of New York). Lexington, Scott county, Indiana. C. D. Walcott and C. Van Deloo, collectors.

No. 350. Carboniferous limestone. Crawfordsville, Indiana. C. D. Walcott, collector. 1877.

On Cordania, a Proposed New Genus of Trilobites.

By John M. Clarke.

In the Palæontology of New York, volume vii, 1888, certain cephala and pygidia of trilobites from the Upper and Lower Helderberg and Hamilton groups of various localities in the State of New York and elsewhere were tentatively referred to the genus PHAETHONIDES as defined by Angelin. A careful restudy of these fossils and review of the literature pertaining to them, educes the fact that Angelin included under his redefinition of this term PHAETHONIDES, forms which Barrande, the author of the name, never intended to bring into so close association, and which can not be properly regarded as congeneric.

The name PHAETON was introduced by Barrande in 1846* for a genus of trilobites, built on the general plan of PROETUS, but having a dentate pygidium. The type of the group was *Phaeton Archiaci*, from the etage E. This name, however, had been used by Brisson in 1770 for a genus of birds. In 1847, Corda† observed this fact of synonymy and substituted for Barrande's term, the name PRIONOPELTIS. He defined the groups clearly and at length, describing all the parts of the animals, and subdivided his twelve species into two principal groups: A, those with simple, uncarinate cephalic margin; B, those with this margin carinate; and of these groups the first was divided into those (a) with 8 lateral pygidial spines, (b) with 7, (c) with 6 or 5 such spines. An excellent illustration was given of the species *P. Polydorus*, a member of the second division of the first group, though the first species of his typical group is his *P. Priamus*. In the first volume of the "Systeme silurien du Centre de la Boheme," in 1852, Barrande did not formally withdraw his term PHAETON, nor acknowledge its preoccupation. He there retains the term in a subgeneric sense, using it as equivalent to his "Groupe B" of the Proeti, viz.; that having the margin of the pygidium ornamented with spines.

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* Notice préliminaire sur le systéme silurien et les Trilobités de Bohême, p. 62.

† Prodrom einer Monographie der Böhmischer Trilobiten, p. 122.

It is evident, however, that Barrande was disposed at this time to relinquish this term, for in the historical introduction to volume i, the name Phaetonides appears as equivalent to Phaeton, but without remark or comment.* This is a part of the work which it is fair to assume was prepared after the body of the text was completed. It was not until 1859 that Barrande formally proposed to replace the term Phaeton with Phaetonides.† This author also demonstrated, in 1852, that eight of Corda's proposed species of Prionopeltis, including *P. Priamus* and *P. Polydorus*, were synonymous with his (Barrande's) *Phaeton Archiaci.* This last named species, therefore, becomes the type of the genus Prionopeltis, but the generic term, Phaeton, Barrande, has not the least title to recognition.‡

Angelin, in 1854 and 1878,§ had adopted the term Phaethonides (with this spelling), quoting Barrande as the authority for the name, but including under it not only species with a dentate pygidium, but also those in which the pygidial margin is entire; the only species described by him being one of the latter class, *Asaphus Stokesi*, Murchison. This author's conception of the genus was in one sense essentially equivalent to that of Corda's interpretation of Prionopeltis, since the forms included by the latter in his group B (*P. Ascanius*, *P. Astyanax*) have been proved to possess pygidia with entire margins, and Novák has separated them under the name, Tropidocoryphe (type, *Proetus filicostatus*, Novák). The fossils referred to Phaethonides, Angelin, in the volume of the Palæontology of New York already cited, agree with that author's diagnosis. They all possess entire pygidial margins, though the tubercles with which some are provided, become spinules on the margin and give it the appearance of being dentate. At the same time they are not congeneric with the holopygous species included in Novák's Tropidocoryphe. It is evidently necessary to restrict the term PRIONOPELTIS closely to typical forms agreeing with Barrande's *Ph. Archiaci* and *Ph. striatus*, for Novák has also shown good reasons for separating from this association forms like *Phaeton planicauda*, Barrande, and has given to this restricted group the name, PHAETONELLUS.

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* Page 42.

† Parallèle entre les dépôts siluriens de Bohême et de Scandinavie, p. 18.

‡ We feel compelled to differ from the opinion recently expressed by the late Dr. Novák in regard to this point (Dames and Kayser's Palæontologische Abhandlungen, Neue Folge, Bnd. 1, p. 11, 1890), who speaks of Prionopeltis as "insufficiently characterized," and considers it better to retain Phaetonides. It could be wished that genera were as clearly defined in these days as was this genus of Corda's, 45 years ago.

§ Palæontologia Scandinavica, pt. I, p. 21.

The American species have a cephalon with a thickened, usually elevated margin, continued into short genal spines. The surface of the ante-lateral limb is concave, the eyes well forward and close together as in CYPHASPIS. The glabella has the form of that in ARETHUSINA, is short, ovoid, has two conspicuous basal lobes, and bears the trace of a pair of short lateral furrows, which are situated at about the mid-length of the glabella, and under favorable circumstances in an internal cast, are seen to bifurcate slightly at their proximal extremities. The number of the thoracic segments has not been ascertained, but specimens found of *Ph. gemmæus*, of the Hamilton group indicate that the number was not more than ten, and that the forms were proetoid in this respect. The pygidium is always relatively large, subsemicircular in outline, the rhachis and pleura abundantly annulated, from 7 to 12, on the former and from 6 to 8 on the latter. The pleural annulations are subequally duplicate. The rhachis does not extend to the margin. The surface is tubercled, the tubercles being irregularly scattered over the cephalon, and arranged in regular rows on the segments and annulations. These tubercles sometimes take the form of spinules (*Ph. arenicolus*, *Ph. gemmæus*) and extend beyond the margin of the pygidium, but they seem never to have their insertion on the margin itself.

This group of trilobites which we propose to term CORDANIA (*Phaethonides cyclurus*, Hall; type), may be said to show alliance to PROETUS in the structure of the pygidium and thorax, to CYPHASPIS in the cephalon generally, and to ARETHUSINA in its glabella in particular. It differs from the TROPIDOCORYPHE of Novák (*Proetus filicostatus*) in the latter having a proetoid, subtriangular glabella, comparatively large and distant eyes, and a pygidium with less conspicuously duplicate annulations and shorter rhachis.

In American faunas this genus is well represented in species, its earliest members being *Cordania cyclura*, Hall (sp.), from the

Lower Helderberg group of New York, and *C. Macrobius*, Billings (sp.), from a similar faunal association at Square Lake, Maine. There is a large undescribed species known to the writer in the Oriskany sandstone of New York; *C. arenicolus*, Hall (sp.), occurs in the Schoharie grit and Corniferous limestone, *C. varicella*, Hall (sp.), in the Corniferous limestone, and *C. gemmæus*, Hall (sp.), in the Corniferous and Hamilton groups. *Asaphus* (*Proetus*) *Stokesi*, Murchison, is probably a member of the same group, and it may be suggested that the pygidium figured by Novák as *Arethusina peltata*, sp. nov., from the Hercynian, possesses a striking similarity to that of Cordania.

An interesting species was described by the late Mr. Meek in 1877, from the Devonian of Steptoe Valley, Nevada, under the name, *Proetus* (*Phaeton*) *denticulatus.* The pygidium of this form is short, with a very short, relatively broad rhachis and a row of deep denticulations about the margin. The surface is not otherwise spinous. A glabella found in association with it is distinctly proetoid. Mr. Meek's figures of this fossil were reproduced in the Palæontology of New York, volume vii (pl. xxv, figs. 14, 15), and in the discussion of the species (there referred to Phaethonides (?)), attention was directed to its similarity in form to *Phaeton planicauda*, Barrande, the species since taken by Novák as the type of his Phaetonellus. As the latter genus is now defined, *P. denticulatus* is an excellent representative of it.

PRELIMINARY NOTE.

The following paper may seem out of place in the report of the State Geologist, and its presence in this connection may require some explanation. Since the completion of volume IV, Palæontology of New York, I have contemplated the preparation of illustrated catalogues and handbooks in this department, as a part of the museum publications. This subject had received the special attention and consideration of the trustees during several years previous to 1883. Before this time the means of illustration for the museum reports were irregular and uncertain, depending upon the State Printer, whose contracts for printing were not uniform, sometimes providing for lithographic work, and at others we were without such provision. On this account the scientific contributions to the museum reports were irregular and no plan could be made for carrying out such publications as were required of a museum having the objects and purposes as expressed by the law of 1871, chapter 557. When the law of 1883 was framed, this subject entered into the consideration of the trustees, as shown by the following extract:

* * *; "and the trustees of said museum shall be authorized to publish each year the scientific contributions of said staff and such other original scientific contributions as they may deem expedient, which publication shall be in lieu of the reports now required by law from the State Geologist and State Entomologist, and the scientific papers communicated each year to the Legislature along with the annual report of said trustees;" * * * "and by means of printed handbooks describing said collections, and in such other ways as may be practicable, to make said museum a means of instruction to the citizens of the State."

"In order to provide for the expense of printing the aforesaid scientific publications and in order to increase the usefulness and efficiency of said museum as aforesaid, the annual appropriation to be made for its maintenance shall be fifteen thousand dollars, to be paid on vouchers approved by said trustees."

For the purpose of carrying out this provision of the law the additional sum of $5,000 was added to the previous annual appropriation of the museum. At that time the writer had in preparation and well forwarded a paper upon the genera of the fossil Lamellibranchiata. Also in a forward state of preparation a monograph of the Dictyospongidæ, of which preliminary notices had appeared in the museum reports for 1862 and 1881. The Report for 1862 was published in 1863, and the Report for 1881 was published in 1884; the paper on the Dictyospongidæ having been published in 1882 in advance of the Report. Besides these other papers were in progress corresponding with the subjects under investigation for the volumes on the Palæontology.

The monograph upon the Dictyospongidæ, as far as it had progressed, was brought before the Trustees of the State Museum in January, 1885, and the following resolution was passed:

Resolved, That the monograph of Director Hall, on Dictyospongidæ, be published by the museum as Bulletin No. 1.

However, when I asked for the means of completing and publishing the work, it was refused. After the completion of volume V, part I, I brought before the trustees, the subject of a bulletin upon the Genera of Lamellibranchata asking for means of completing the work which had been already carried on to a considerable extent, and ten plates of these illustrations had been already published with my report for 1881. To this application I received a refusal. After this I had in progress and well forwarded, the material for a bulletin upon the Bryozoa, which, at the request of the secretary of the Board of Regents, in 1889, I carried on to near completion at my own expense; but when presented for publication it was refused.

In order to avoid the humiliation of a farther refusal, I have ceased asking for the means of publication, but on several occasions have, brought before the museum committee the drawings of Dictyospongidæ, as far as completed, and also the drawings of fossil Corals, which had been made to the number of at least eighty quarto plates, before the passage of the law of 1883; on each occasion asking for the consideration of the subject, and the suggestion of some plan for their publication.

The bulletins which have been published under the provisions of the law of 1883, are the following:

"**Volume 1.** 6 *nos.* *Price,* $1 *in cloth.*

"1 Marshall, W: B. Preliminary list of New York unionidæ. 19 p. Mar. 1892. *Price,* 5 *cents.*

"2 Peck, C: H. Contributions to the botany of the state of New York. 66 p. 2 pl. May 1887. *Price,* 15 *cents.*

"3 Smock, J: C. Building stone in the state of New York. 152 p. Mar. 1888. *Price,* 30 *cents.*

"4 Nason, F. L. Some New York minerals and their localities. 19 p. 1 pl. Aug. 1888. *Price,* 5 *cents.*

"5 Lintner, J. A. White grub of the May beetle. 31 p. il. Nov. 1888. *Price,* 10 *cents.*

"6 Lintner, J. A. Cut-worms. 36 p. il. Nov. 1888. *Price,* 10 *cents.*

"*Price to advance subscribers,* 50 *cents a volume.*

"**Volume 2.** 4 *nos.* *Price,* $1 *in cloth.*

"The first six bulletins are paged independently; the numbers of v. 2 are paged continuously as a single volume.

"7 Smock, J: C. First report on the iron mines and iron ore districts in the state of New York. 5+70 p. map 58+60 cm. June 1889. *Price,* 20 *cents.*

"8 Peck, C: H. Boleti of the United States. 96 p. Sept. 1889. *Price,* 20 *cents.*

"9 Marshall, W: B. Beaks of unionidæ inhabiting the vicinity of Albany, N. Y. 23 p. 1 pl. Aug. 1890. *Price,* 10 *cents.*

"10 Smock, J: C. Building stone in New York. 210 p. map 58+60 cm. tab. Sept. 1890. *Price,* 40 *cents.*

"11 Merrill, F. J. H. Salt and Gypsum Industries of New York. 89 p. maps. April, 1893. *Price,* 40 *cents.*"

Finding it impossible to obtain publication as I had expected and which had been promised to me before the passage of the law of 1883, I have asked of the Legislature the means of illustrating my annual reports as State Geologist, and the following paper is the first to appear under this authorization. Certainly such a paper would have been more appropriately published as a bulletin of the State Museum of Natural History, but in this direction publication has been persistently refused.

The preliminary work upon the Genera of Lamellibranchiata has not been continued, and the bulletin in preparation ten years ago remains without material progress. The bulletin on the Bryozoa proposed, and prepared for publication in 1888 and 1889 yet remains unpublished. The work upon the Dictyospongidæ, which was originally recommended to constitute bulletin No. 1 of the museum series, has progressed mainly in the direction of the accumulation of material, and the publication of new species in the report for 1889, until the present year. The continuation of the present paper upon the Brachiopoda is already far advanced and it is expected that it will be published in the annual report of the State Geologist for 1893. The second part will include the spire-bearing genera, the Rhynchonellidæ, Pentameridæ and the Terebratuloids.

With a continuation of the present provisions for illustrating the report of the State Geologist, we may hope within a few years, to retrieve in some measure, the loss of time and publication, suffered during the past ten years.

AN INTRODUCTION

TO THE STUDY OF

THE BRACHIOPODA

INTENDED AS

A HAND BOOK FOR THE USE OF STUDENTS.

By James Hall, assisted by John M. Clarke.

PREFACE.

The accompanying paper has been communicated as a part of and to the report of the State Geologist with the object of presenting to the public an example of the kind of work I had proposed to do under the provisions of the law of 1883, which appropriated the sum of $5,000 annually for the purposes of publishing the "scientific contributions" of the "museum staff and such other scientific contributions as they," the trustees, "may deem expedient; and by means of printed handbooks describing said collections and, in such other ways as may be practicable, to make the said museum a means of instruction to the people of the State."

It had long been my desire to accomplish by some means a diffusion of the knowledge of the Palæontology of the State as a guide and help to students in geology in our colleges and higher schools. In the earlier work of the Palæontology of the State, when the publications were compelled to follow immediately upon the acquisition of fossils from the field, it was necessary to include all the classes of organisms from the formation, or series of formations, under discussion, and, therefore, the earlier volumes present only a very partial attempt at a biological arrangement of the material. As soon as collections had accumulated to such a degree as permitted the treatment of each class of fossils, from one or several formations, in their biological relations they were so discussed and illustrated.

It was not until the time of the publication of the fourth volume upon the Devonian Brachiopoda that such a method of treatment could be adopted, and during this work I became more fully aware than ever before of the necessity of preparing an epitome or synopsis of that volume, and also including the preceding volumes, so far as related to the brachiopoda, which might bring before the student a clearer appreciation of the generic features of this class of fossils. With this idea in mind arose the conception of treating this subject in the order of geologic time. To one who had worked among the fossils of the older rocks upward through all the formations to the Carboniferous, it was impossible to avoid the conviction that the modification of similar forms in successive geologic periods, and the final disappearance of some of them, either from slow degeneration, or after extravagant manifestations of certain characters, had a significance which had not been fully understood or appreciated by writers upon this class of fossils.

With this conception in mind I began the preparation of what was then intended to be a supplement to Volume IV of the Palæontology of New York. After waiting for more than twenty years for the means of making the necessary collections and for publication, this supplement has expanded into volume VIII, parts i and ii of the Palæontology of New York. From the studies carried forward among the brachiopoda in preparing these volumes has come back to the writer more strongly than ever the importance of preparing a synopsis of the genera which may form a useful handbook for advanced students in geologic studies.

Through the action of an intelligent Legislature and the appreciation of a wise Executive, means have been furnished for making this publication.

The discussions of the genera and their relations are the same as those given in the volumes just named, with corresponding illustrations.

In order to present the subject to the student, in not too abrupt a manner, it has seemed necessary to precede the generic discussions by some general elementary explanations.

There is at present no work in the English language meeting the modern requirements of a guide or introduction to the study of the Brachiopoda in which elementary facts in regard to structure, function, habits and distribution of these animals, the distinguishing characters and systematic relations of their genera, are concisely brought together in one place. The literature pertaining to both recent and fossil forms is widespread and in many languages, beyond the reach of most students, and sometimes accessible with difficulty even to investigators. Dr. Œhlert has admirably summarized the subject in Fischer's Manual de Conchyliologie (1887) and Prof. von Zittel has treated the group still more succinctly in his "Handbuch von Paläontologie." In bringing to a summary the investigations of the palæozoic genera of the brachiopoda as expressed at length in volume VIII, parts i and ii of the Palæontology of New York, it has seemed desirable to present to students an abridgment of the conclusions there derived, with the addition of some introductory and more general descriptive matter. The outcome of this purpose is the present work which it is hoped and believed will be found serviceable to students of both palæontology and geology, and help to nourish the growing interest in the structure and history of these important animals. The work has been prepared for the use of American students to whom it is cordially dedicated.

JAMES HALL,
State Geologist.

THE BRACHIOPODA.

GENERAL CHARACTERS OF THE CLASS.

The Brachiopoda are marine animals inclosed in bivalved, equilateral and inequivalved shells.

As a group they attained a most prolific and multiform development during the Palæozoic and Mesozoic eras in the history of the earth, while their existing representatives are comparatively few in number. A knowledge of their variations in form, structure and in time is, therefore, of highest importance to the student of biology and geology.

In brief, these animals are characterized by the unequal development of the two lobes of the cuticular integument (*mantle*), which results in the unequal size of the valves. The mouth is situated subcentrally or posteriorly and is surrounded by elongated, usually spiral cirrated expansions, which occupy the anterior portion of the valves and serve as conveyancers of food-bearing water-currents; in part, also, subserving the function of respiration. There is a simple œsophageal nerve-ring with an inferior or sub-œsophageal ganglion, and various small accessory nerve-knots. The sexes are distinct in all species in which these characters have been studied.

Habits of Life. From our knowledge of existing species it is believed that all Brachiopoda, at some period of their existence, are attached to extraneous objects. To this statement, there is but one known exception among living forms, namely, the linguloid, *Glottidia Audebardi*. In the fossil (Palæozoic) genera Pholidops and Pseudocrania there is no evidence of attachment of any kind, either in the young condition (Pholidops), or in the mature and senile stages of growth.

Fixation is usually effected by means of a fleshy arm or pedicle of greater or less length, protruded through an aperture at, or near the apex of the larger valve. In certain genera, however, fixation is attained by the cementation of the lower valve (Crania), or of the umbonal portion of the larger valve (Strophalosia, Davidsonia, Leptænisca, Chonopectus, etc.) to the external object.

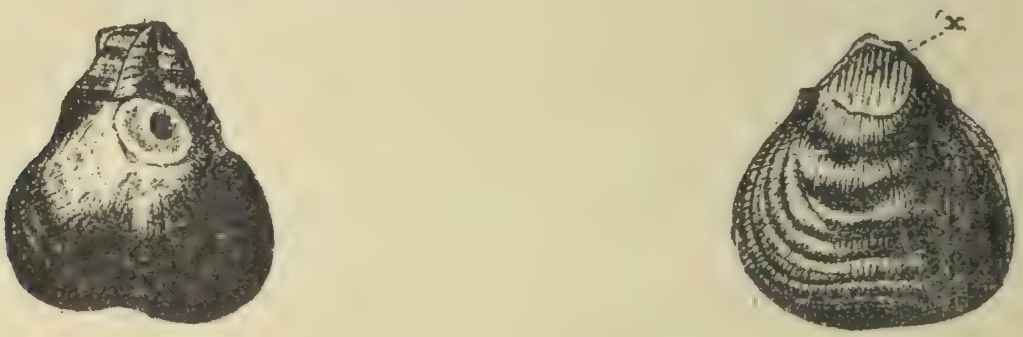

Fig. 1.—*Derbya Bennetti.* An adult example in which the scar of attachment (x) is retained. A *Crania* is attached to the umbo of the brachial valve.

The former mode of attachment takes place at an early stage in the growth of the animal, and is continued in some instances throughout the remainder of its life (Terebratella, Magellania, Hemithyris, etc.); at other times the pedicle becomes atrophied after adolescence or maturity, by the incurvature of the beak of the larger valve, or by the closing of the aperture for its passage by adventitious deposits of calcareous matter, and the shell thus becomes free. This condition is true of some living genera, while it obtained among the majority of Palæozoic species,

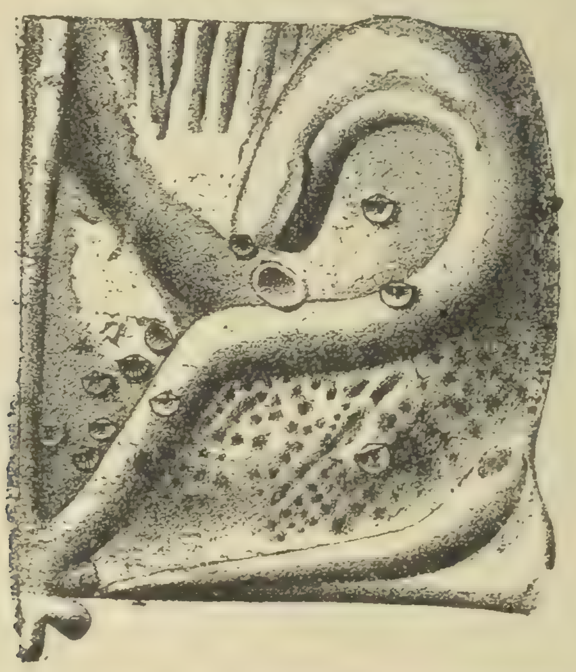

Fig. 2.—A portion of the inner surface of a brachial valve of *Productus*, to which a number of very young shells of *Derbya* are attached by the cementation of the pedicle-valve. It will be observed that most of the attached shells have the hinge line parallel to that of the *Productus*, though their relative positions are inverted.

especially those of the genera STROPHOMENA, RAFINESQUINA,* STROPHEODONTA, LEPTÆNA, PLECTAMBONITES, CHONETES, PRODUCTUS, etc.

Fixation by calcareous cementation also began early in life, and in CRANIA, DAVIDSONIA, LEPTÆNISCA and RICHTHOFENIA, continues during the remainder of the animal's existence, the attached valve frequently being fixed by its entire outer surface. In other genera the condition of attachment was restricted to early, or adolescent growth stages; (ORTHOTHETES, DERBYA, STROPHALOSIA, OLDHAMINA, etc.),† the shell in after life becoming detached from its mooring, but usually retaining a scar or deformation of the surface in the umbonal region. Attachment by cementation has been shown by JACKSON to induce among the Lamellibranchiates a strongly vescicular structure in the attached shell; and it may be a rule of more general application, as it is seen in certain attached annelidan tubes, e. g., *Cornulites proprius;* and among those brachiopods which are attached by a considerable surface of the shell, such as CRANIA and, especially, the extravagant RICHTHOFENIA, the vesciculation of the shell-structure is a striking feature.

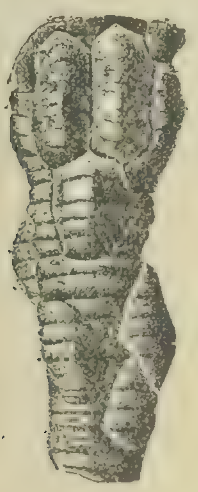

FIG. 3.—A fragment of a crinoid column covered with a number of individuals of *Crania socialis*, which retain the marks of the sutures between the segments of the crinoid.

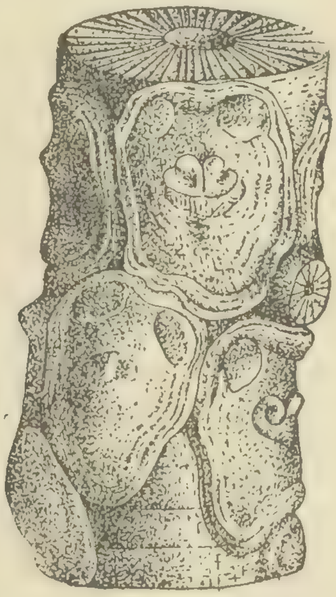

FIG. 4.—Lower valves of *Crania quadrata* attached to column of a crinoid, the upper valves having been removed by natural causes (DAVIDSON).

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* Not infrequently in STROPHOMENA and RAFINESQUINA a minute pedicle-passage is retained in the mature condition of the shell, but it is always evident that the shell could not, at this period of growth, have been supported by any muscular apparatus which might be protruded through this aperture. In *Rafinesquina alternata*, of the Lower Silurian, it is seen that the contraction of the aperture has increased most rapidly about the base of the pedicle, and the internal opening of the passage may be altogether closed, while the external opening remains.

† *Craniella Ulrichi*, of the Lower Silurian, is the only inarticulate brachiopod which appears to have been thus attached in early growth and to have become free at maturity.

Glottidia Audebardi has been mentioned as a species in which attachment exists at no stage of development. The muscular pedicle of the animal penetrates marine sediments and gathers about itself a mass of agglutinated grains of sand, fragments of shell and bits of sea-weed, forming thus a distinctly free capsule or tube, after the manner of many worms. This may be regarded as a sort of attachment, as the animal, after the formation of this tube, is at no time free from it.

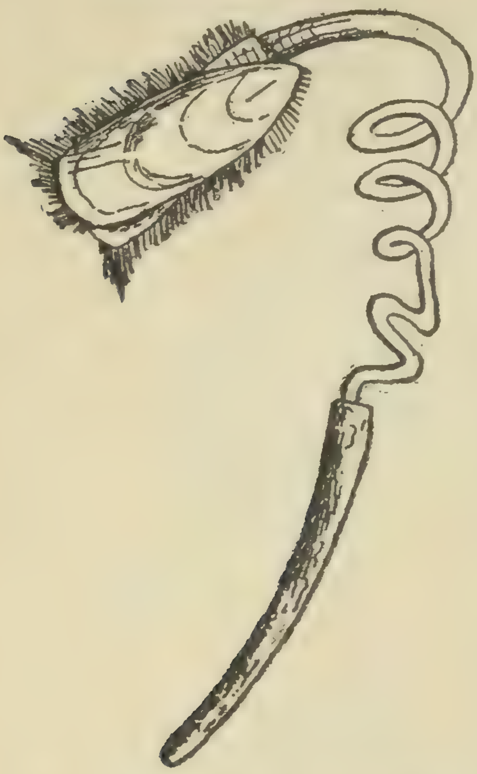


FIG. 5.— *Glottidia Audebardi* (MORSE).

In the genus STROPHALOSIA, the attachment by the substance of the valve was frequently aided by the long spines with which the attached valve is furnished, these adhering to, or embracing the foreign object. An individual of *Strophalosia radicans*, having become lodged in the cavity between the calyces of a compound coral (*Acervularia*), has anchored itself essentially by its spines alone, only the posterior edge of the valve coming into contact with its host.

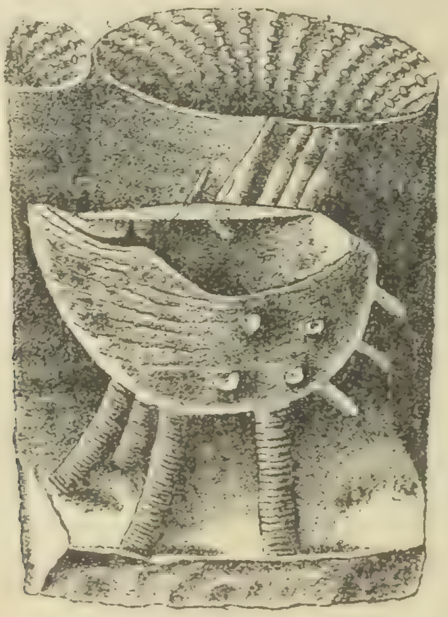


FIG. 6 — *Strophalosia radicans*, situated in a cavity between the calyces of *Acervularia*, and attached by its spines. X 3.

ETHERIDGE has described some small productoids (*Etheridgina complectens*), which are attached to columns of crinoids by the encircling of the spines, as though at some time these spines had been flexible and prehensile organs. The same author also mentions a species of Chonetes apparently attached by the spines on the cardinal margin, but this observation seems to require verification. *Productella navicella*, of the Devonian, has the spines in the umbonal region of the large valve curved upward, those from opposite sides passing each other; like a man's arms extended and folded above his head. These were undoubtedly clasping or anchoring spines.

It is even possible that *fixation by mooring*, or temporary attachment was effected by an extravagant growth and enfolding of the anterior portions of the larger valve, in some Carboniferous productoids (Proboscidella) which have been described by De Verneuil, De Koninck, Davidson and others.

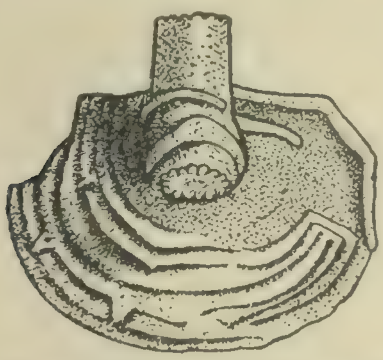


Fig. 7.—*Etheridgina complectens* attached by its spines to a crinoid column. (Etheridge.)

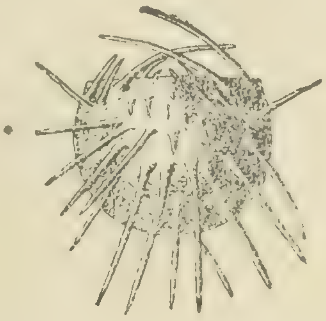


Fig. 8.—*Productella navicella*, showing the clasping spines in the umbonal region. Hamilton group; New York.

The capability of locomotion in the brachiopods was very limited. During the unattached condition the spawn were active swimmers. Terebratulina becomes attached very early in its history, while Discinsca is fixed only after many of the adult characters have been assumed. It is difficult to believe that any power of locomotion was possessed by the ancient forms in which the pedicle was atrophied at maturity and the shell thus set free, as Spirifer, Productus, some forms of Athyris, etc.; or that the animals could depend on other than circumstantial causes for a change of place. Some writers have suggested that the long spines with which several genera, especially Productus, are furnished, may have been aids to such motion, but as these spines were unquestionably rigid bodies, it is difficult to believe that they could have had any part in the voluntary motion of the animal.

Distribution. The brachipods are gregarious in habit and over a given area of the sea-bottom a single species will frequently be found in great numbers. "Prof. Jukes got immense numbers of *Waldheimia flavescens* or *australis* while boating in Australia among the reefs. M. Vélain picked up a small species of Kraussina in vast numbers on the shore in the interior crater of the island of St. Paul, the shells being alternately covered with water and left dry at every tide. *Kraussina rubra*, from the coast of Natal in South Africa, was described by Dr. Gray as having been found attached in great numbers to Ascidia and stems of seaweeds" (Davidson). It is said that more than twenty bushels of *Lingula anatina* were picked up after a violent storm on the coast of Manilla, and Œhlert states that on the coast near Guernsey were found at one time about two hundred specimens of *Cistella cistellula*.

Some of the genera and species of brachiopods possess remarkable power of resistance to physical conditions, and are found at various depths. The genus Discinisca has representatives within five fathoms of the surface and at a depth of 2,500 fathoms; the species *Terebratulina caput-serpentis* ranges from near the surface to a depth of 1,195 fathoms. The greatest depth from which any species has been dredged is 2,945 fathoms (*Liothyrina Wyvillii*).

The evidence afforded by living species is as yet insufficient to determine the effects of bathymetric conditions upon specific characters. It is evident that different species are variously affected or inequably resistant to these influences; but as a general rule, different species or associations of species are found at different depths.

In the summary of bathymetric distribution of living species as given by Œhlert, it appears that in the *Littoral Zone*, or that between tides, there are 17 known species, 7 of which are peculiar to it; in the *Laminarian Zone* (to a depth of 15 fathoms), there are 46 species, 15 of which are peculiar to it; in the *Zone of Nullipores* (from 15 to 50 fathoms) are 39 species, of which but 3 are restricted to it; in the *Zone of Brachiopods* (from 50 to 278 fathoms), 58 species have been found, and 20 of these are not known elsewhere; in the *Abyssal Zone* (from 278 to 2,945 fathoms) have been found 30 species, of which 12 do not occur elsewhere. It is, however, to be observed that in these conventional divisions the so-called restricted species occur either in zones of great vertical extent or those where organic life generally is the most prolific. There is no evidence that this bathymetric range of the brachiopods has been effected by any other causes than restricted powers of self-distribution, in co-operation with a given capacity of resistance to physical forces.

An important factor in their distribution is the influence of heat and cold, to which the brachiopods are evidently sensitive; a fact which makes itself apparent in their geographical dissemination. There are some species (*Hemithyris psittacea*, *Liothyrina arctica*, *Terebratella Spitzbergensis*) which flourish best in the cold waters about the north pole, and never transgress into the warmer seas where the brachiopods are most prolific. At the same time there are a few species that are world-wide in their distribution (*Liothyrina vitrea*, var. *minor*, *Terebratulina caput-serpentis*), and, as ŒHLERT observes, these are species which also possess the greatest bathymetric range.

The following table of the *Geographical Provinces* and the species embraced within them has been largely drawn from that compiled by ŒHLERT in FISCHER'S *Manuel de Conchyliologie*. This may be studied in connection with the accompanying map of the World, upon which is plotted the distribution of living species.

ARCTIC PROVINCE:

Atretia gnomon.
Crania anomala.
Discinisca atlantica.
Liothyrina arctica.
Macandrevia cranium.
Dallina septigera.
Magellania tenera.
Rhynchonella (*Hemithyris*) *psittacea.*
Terebratalia frontalis.
Terebratella Spitzbergensis.
Terebratulina caput-serpentis.

BOREAL PROVINCE:

Atretia gnomon.
Cistella cistellula.
Crania anomala.
“ “ var. *alba.*
Laqueus Californicus (*Megerlina Jeffreysi.*)
Macandrevia cranium.
Dallina septigera.
Rhynchonella (*Hemithyris*) *psittacea.*
Terebratella Frielii.
T. Labradorensis.
T. Spitzbergensis.
Terebratalia transversa.
Terebratulina caput-serpentis.
T. unguiculata.

LUSITANIAN PROVINCE:

Cistella cistellula.
C. cuneata.
C. neapolitana.
Crania anomala.
Discina striata.
Discinisca atlantica.
Eucalathis ergastica.
E. Murrayi.
E. tuberata.
“ “ var. *mediterranea.*
Gwynia capsula.
Liothyrina sphenoidea.
L. vitrea.
“ “ var. *minor.*
Macandrevia cranium.
Dallina septigera.
Megathyris decollata.
Mühlfeldtia truncata.
“ “ var. *monstruosa.*
Platidia anomoides.
P. Davidsoni.

Platidia lunifera.
Rhynchonella (Hemithyris) cornea.
Terebratulina caput-serpentis.
T. trigona.

WEST AFRICAN PROVINCE:

Dyscolia Wyvilii.
Discina striata.
Lingula parva.
Liothyrina sphenoides.
Mühlfeldtia incerta.
Rhynchonella (Hemithyris) cornea.
Terebratulina caput-serpentis.

SOUTH AFRICAN PROVINCE:

Agulhasia Davidsoni.
Kraussina cognata.
K. Davidsoni.
K. pisum.
K. rubra.
Liothyrina vitrea var. *minor.*

INDO-PACIFIC PROVINCE:

Discinisca stella.
Lingula affinis.
L. anatina.
L. hians.
L. hirundo.
L. Reevii.
Liothyrina vitrea, var *minor.*
Mühlfeldtia sanguinea.
M. truncata.
Rhynchonella (Hemithyris) Grayi.
Terebratella Frielii.
Terebratulina Cumingi.
T. japonica.
T. Murrayi.

AUSTRALO-ZEALANDIAN PROVINCE:

Crania Suessi.
Kraussina Atkinsoni.
K. Lamarckiana.
Lingula exusta.
L. Murphiana.
L. tumidula.
Liothyrina Wyvillii.
Magasella Evansi.
M. fibula.
M. inconspicua
Magellania flavescens
M. lenticularis.
Mühlfeldtia truncata.
M. Willemoesi.
Rhynchonella (Hemithyris) nigricans.
Terebratella cruenta.
T. rubicunda.
Terebratulina cancellata.

JAPANESE PROVINCE:

Crania japonica.
Discinisca stella.
Laqueus pictus.
L. rubella.
Lingula Adamsi.
L. jaspidea.
L. lepidula.
L. smaragdina.
Liothyrina Dalli.
L. vitrea var. *Davidsoni.*
Macandrevia cranium.
Magasella Adamsi.
M. Gouldi.
Magellania Grayi.
Dallina Raphaelis.
Mühlfeldtia sanguinea.
Rhynchonella (Hemithyris) Döderleini.
R. lucida.
R. psittacea.
Terebratalia coreanica.
T. frontalis.
Terebratella Mariæ.
T. Spitzbergensis.
Terebratulina caput-serpentis.
T. Crossii.
T. Cumingi.
T. japonica.
T. radiata.

ALEUTIAN PROVINCE:

Magasella aleutica.
M. radiata.
Rhynchonella (Hemthyis) psittacea.
Terebratalia frontalis.
Terebratella Lamanoni.
T. transversa.
Terebratulina unguiculata.

CALIFORNIAN PROVINCE:

Glottidia albida.
G. Palmeri.
Laqueus californicus.

Liothyrina Stearnsi.
Platidia anomoides.
Terebratalia obsoleta.
T. occidentalis.
Terebratella transversa.
Terebratulina unguiçulata.

PANAMIC PROVINCE:

Discinisca Cumingi.
D. lamellosa.
Glottidia Audebardi.
G. semen.
Liothyrina uva.

PERUVIAN PROVINCE:

Discinisca Cumingi.
D. lævis.
D. lamellosa.
Liothyrina Wyvillii.
Magellania Wyvillii.
Terebratalia dorsata.

MAGELLANIAN PROVINCE:

Liothyrina Moseleyi.
L. Wyvillii.
Magasella flexuosa.
M. lævis.
M. rhombea.
Magellania Kerguelenensis.
M. venosa.
Platidia anomoides.
Rhynchonella (Hemithyris) nigricans.
Terebratalia dorsata.
Terebratella pulvinata.
Terebratulina Murrayi.
T. septentrionalis.

PATAGONIAN PROVINCE:

Liothyrina uva.

CARIBBEAN PROVINCE:

Bouchardia rosea.
Cistella Barrettiana.
C. lutea.
C. Schrammi.
C. Schrammi var. *rubrotincta.*
Crania Pourtalesi.
Discinisca Antillarum
D. Cumingi.
Discolia Wyvillii.
Glottidia Antillarum.
G. pyramidata.
Liothyrina Bartletti.
L. incerta.
L. Moseleyi.
Platidia anomoides.
Terebratulina Cailleti.
T. caput-serpentis.
Thecidium mediterraneum.

TRANSATLANTIC PROVINCE:

Crania Pourtalesi.
Discinisca atlantica.
Glottidia pyramidata.
Dallina floridana.
Platidia anomoides.
Terebratulina Cailleti.
T. septentrionalis.

EXPLANATION OF MAP.

The geographical position of each species is represented by a black circle inclosing a number, which refers to the following alphabetical list of names:

(The fact is recognized that some of the names here employed probably represent developmental phases of other species, but as it is impossible with our present knowledge to ascertain of how many such names this is true, the commonly accepted designations are therefore employed.)

1. Agulhasia Davidsoni.
2. Atretia Brazieri.
3. A. gnomon.
4. Bouchardia rosea.
5. Cistella Barrettiana.
6. C. cistellula.
7. C. cuneata.
8. C. Kowalevskii.
9. C. lunifera.
10. C. lutea.
11. C. neapolitana.
12. C. Schrammi.
13. “ “ var. rubrotincta.
14. C. Woodwardiana.
15. Crania anomala.
16. “ “ var. alba.
17. C. japonica.
18. C. Pourtalesi.
19. C. Suessi.
20. C. turbinata.
21. Discina striata.
22. Discinisca Antillarum.
23. D. atlantica.
24. D. Cumingi.
25. D. lævis.
26. D. lamellosa.
27. D. stella.
28. Dyscolia Wyvillii.
29. Eucalathis ergastica.
30. E. Murrayi.
31. E. tuberata.
32. “ “ var. mediterranea.
33. Glottidia albida.
34. G. Antillarum.
35. G. Audebardi.
36. G. Palmeri.
37. G. pyramidata.
38. G. semen.
39. Gwynia capsula.
40. Kraussina Atkinsoni.
41. K. cognata.
42. K. Davidsoni.
43. K. Deshayesi.
44. K. Lamarckiana.
45. K. pisum.
46. K. rubra.
47. Laqueus californicus.
48. “ “ var. Vancouverensis.
49. L. pictus.
50. Lingula Adamsi.
51. L. affinis.
52. L. anatina.
53. L. exusta.
54. L. hians.
55. L. hirundo.
56. L. jaspidea.
57. L. lepidula.
58. L. Murphiana.
59. L. parva.
60. L. Reevii.
61. L. smaragdina.
62. L. tumidula.
63. Liothyrina arctica.

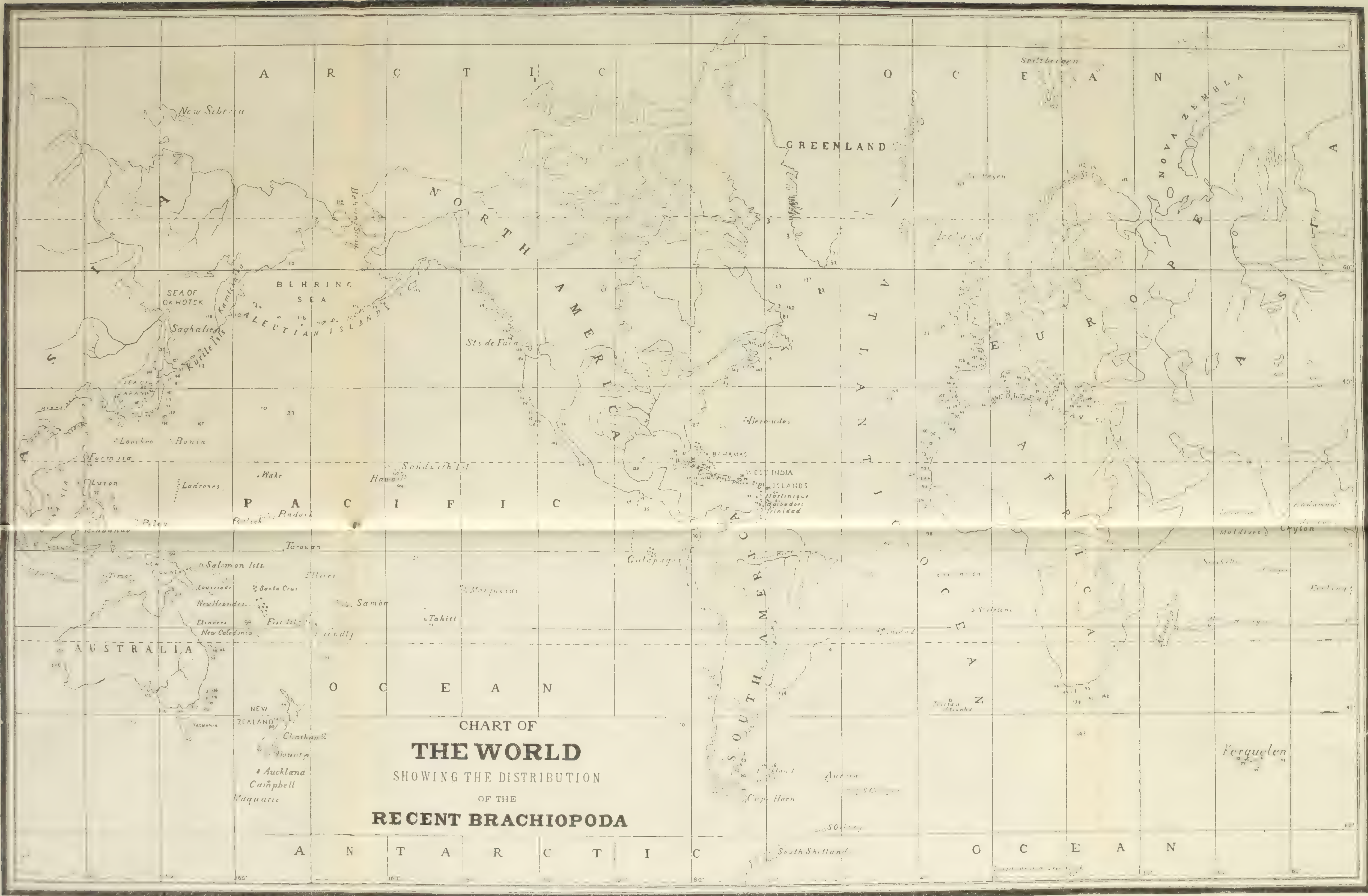


CHART OF
THE WORLD
SHOWING THE DISTRIBUTION
OF THE
RECENT BRACHIOPODA

64. Liothyrina sphenoidea.
65. L. subquadrata.
66. L. vitrea.
67. " " var. cernica.
68. " " " Davidsoni.
69. " " " minor.
70. L. Wyvillii.
71. Macandrevia cranium.
72. Magasella Adamsi.
73. M. aleutica.
74. M. crenulata.
75. M. Evansi.
76. M. fibula.
77. M. flexuosa.
78. M. Gouldi.
79. M. incerta.
80. M. inconspicua.
81. M. Labradorensis.
82. M. lævis.
83. M. patagonica.
84. M. radiata.
85. M. rhombea.
86. Magellania flavescens.
87. M. (Dallina) floridana.
88. M. (Dallina) Grayi.
89. M. Kerguelenensis.
90. M. lenticularis.
91. M. (Dallina) Raphaelis.
92. M. (Dallina) septigera.
93. M. tenera.
94. M. venosa.
95. M. Wyvillii.
96. Megathyris decollata.
97. Mühlfeldtia echinata.
98. M. incerta.
99. M. sanguinea.
100. M. truncata.
101. M. " var. monstruosa.
102. M. Willimoesi.
103. Platidia anomioides.
104. P. Davidsoni.
105. P. lunifera.
106. Rhynchonella cornea.
107. R. Döderleini.
108. R. Grayi.
109. R. lucida.
110. Rhynchonella nigricans.
111. R. " var. pyxidata.
112. R. psittacea.
113. Terebratella Blanfordi.
114. T. (Terebratalia) coreanica.
115. T. cruenta.
116. T. (Terebratalia) dorsata.
117. T. Frielii.
118. T. (Terebratalia) frontalis.
119. T. Gouldi (78).
120. T. Labradorensis.
121. T. Lamanoni.
122. T. Mariæ.
122*a*. T. (Terebratalia) obsoleta.
123. T. (Terebratalia) occidentalis.
124. T. pulvinata.
125. T. rubicunda.
126. T. rubiginosa.
127. T. Spitzbergensis.
128. T. (Terebratalia) transversa.
129. Terebratula (Liothyrina) Bartletti.
130. T. (L.) Dalli.
131. T. (L.) incerta.
132. T. (L.) Moseleyi.
133. T. (L.) Stearnsi.
134. T. (L.) uva.
135. Terebratulina Cailleti.
136. T. cancellata.
137. T. caput-serpentis.
138. T. (Dyscolia) Crossii.
139. T. Cumingi.
140. T. japonica.
141. T. Murrayi.
142. T. radiata.
143. T. septentrionalis.
144. T. trigona.
145. T. unguiculata.
146. Thecidium Barretti.
147. T. (Lacazella) mediterraneum.

COLOR.

The shells of most living species are of light or neutral tints, white or horn-color. The deep-sea species are usually vitreous, translucent and very thin-shelled. A deep orange-red in radiating bands or in solid tints, colors some species (TEREBRATULINA, KRAUSSINA, etc.); light yellows, deep and light shades of green (LINGULA), black in bands (CRANIA) or masses (RHYNCHONELLA) embellish these shells. Even among the fossil species traces of faded color-marks are occasionally observed; DESLONGCHAMPS has described them among Jurassic species, DAVIDSON among the Carboniferous, and KAYSER has found a color-marked RHYNCHONELLA in the Devonian. The large, highly ornamented species of Palæozoic times, with their external sculpture heightened by a brilliant coloring must have been objects of exquisite beauty.

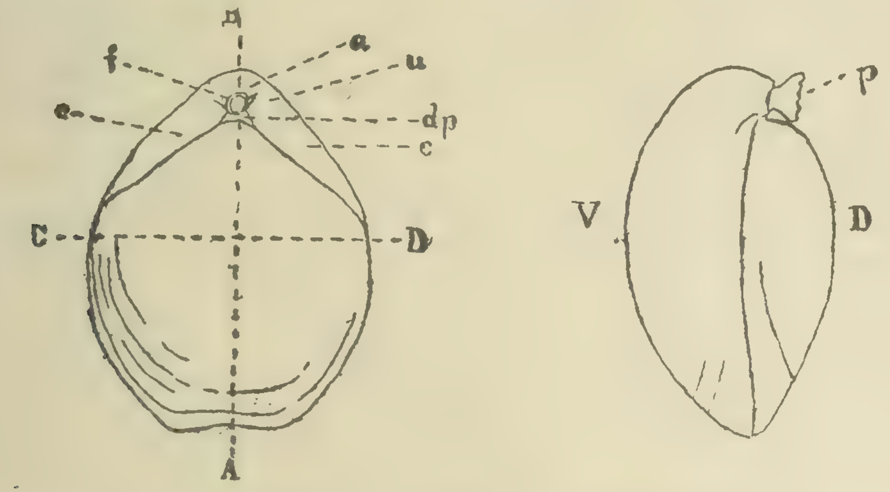
THE SHELL.

External Form and Terminology of its Parts.

The brachiopod shell assumes a great variety of forms. Usually both valves are more or less convex, but they may be almost flat, and one of them is frequently concave, following the curvature of the other. In early age the surface of all is normally smooth, and while many retain this smoothness throughout their existence, the greater number bear radial ribs or plications, or a series of concentric varices and growth-lines.

The valve, which, in youth or maturity, bears at or near its apex, a perforation or fissure, is known as the *pedicle-valve*, as it is through this opening that the pedicle or fleshy arm of attachment is protruded, being attached to the inner surface of the valve by a series of muscular bands. This valve has also been quite generally known as the *ventral*, as it may, from certain considerations, be regarded as lying on the ventral side of the animal. It is usually the larger of the two valves, and has, therefore, been designated by many writers as the *larger valve;* but there is so great a number of instances in which the pedicle-valve is not the larger, that this term is objectionable. This valve bears the teeth or the principal articulating apophyses of the hinge, and has hence been termed the *dental valve*; an unsatisfactory designation, as a vast number of species is provided with no such apparatus. A few writers have called it the *neural* *valve*, because of the location of the principal nerve-ganglia on this side of the body.

The opposite, usually smaller and imperforate valve, is known as the *brachial valve*, as to it are attached the spiral arms or brachia. This is the *dorsal*, *socket* or *hæmal valve* of some writers.



FIGS. 9.—**Front** and profile views of *Terebratula*.

These valves usually have an articulated *hinge* situated beneath the beaks; sometimes they are held together in simple apposition by muscular contraction, but whenever, and to whatever extent the valves are opened by the animal, the basis of the movement is at this posterior margin of the shell.

In discussing the shells of the brachiopods a simple nomenclature has been adopted.

Most writers are agreed in orienting a shell with its beaks upward. That portion of the valves thus lying above a horizontal axis (C—D) passing through the center of the valves, is the *posterior portion*, that below this axis the *anterior portion*. The shell is also divided by a vertical axis (A—B) into equal *lateral parts*. The *apex* of the valves is their acute or obtuse point of

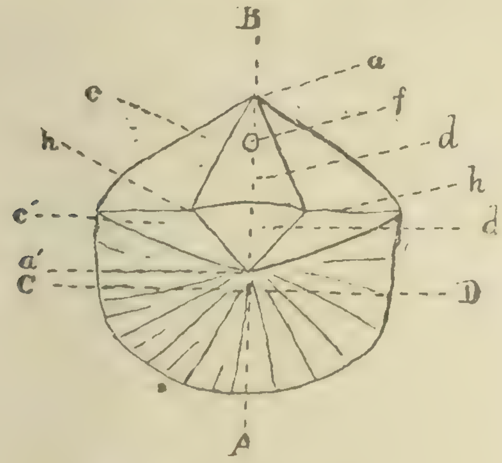


FIG. 10.—*Orthisina*.

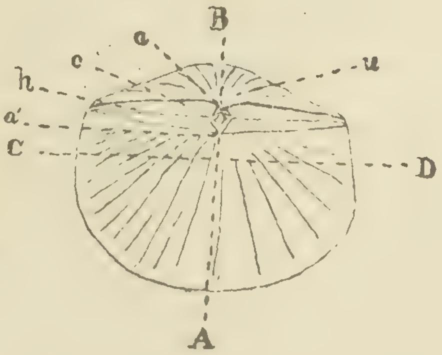


FIG. 11.—*Plectambonites*.

beginning (a, á), the *umbo* (u), the more prominent portion or *beak* including the apex; the *umbonal slopes* are the inclined surfaces about the umbo, except those extending to the hinge margins, which are known as the *cardinal slopes* (c). The *hinge-line* (h) is the straight or curved line along which articulation takes place; the *cardinal extremities* (e) the exsert terminations of this line; the *cardinal area* (c, ca), a triangular vertical or curved surface, distinctly set off from the general surface of the shell and more highly developed on the pedicle-valve. This cardinal area is transsected by a median triangular aperture having its apex at the apex of the pedicle-valve, its base at the hinge-line; this is called the *delthyrium* (dt) and in function it is a passage for the pedicle.

This aperture is usually closed or covered at some period in the history of the organism; in the earliest growth-stages of the shell, and in primitive genera, it is covered by a single convex plate or sheath, known as the *deltidium* (d). In secondary or derived genera (Rhynchonella, Spirifer, Athyris, Terebratula) the deltidium disappears by resorption, at a very early stage of growth, or is never present, and the delthyrium may remain open for a considerable period in the life of the animal; but it eventually becomes more or less completely closed by the gradual formation, along the lateral margins of the delthyrium, of two separate plates (*deltidial plates*, dp), which in the adult condition may either remain discrete or unite along the median line, or having thus united, become coalesced into a single plate (Spirifer, Cyrtina), which has the form of a deltidium but is wholly distinct in origin. Both deltidium and deltidial plates may enclose an oval or circular passage or *foramen* (f) for the protrusion of

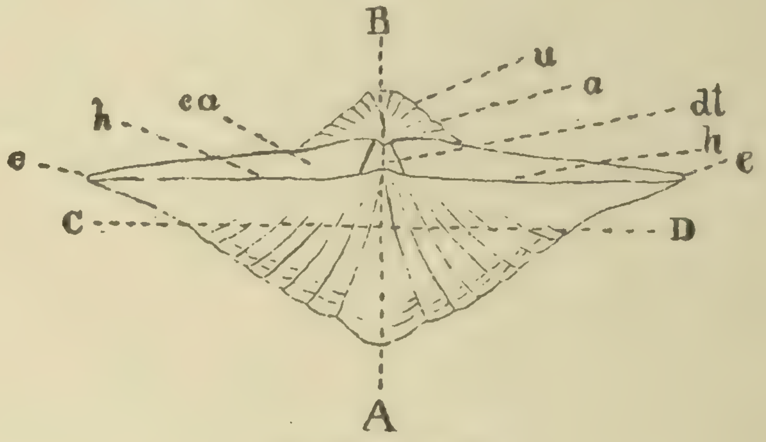
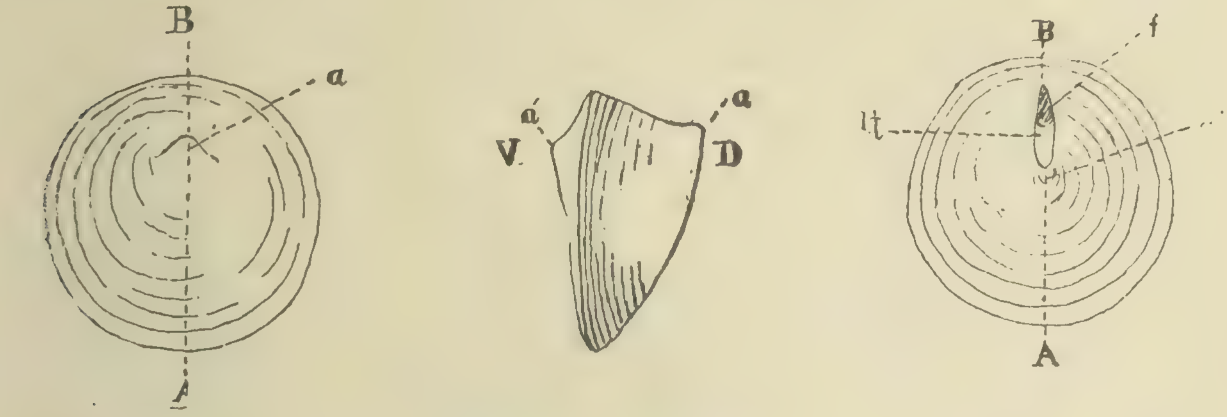


Fig. 12.— *Spirifer.*

the pedicle; in the former the foramen is usually apical, but in the latter it generally lies below the apex, and in both cases it may become entirely obliterated by the later growth of the shell. Likewise both deltidium and deltidial plates may be resorbed in the senile stages of growth.

In some of the edentulous genera, as ORBICULOIDEA and SCHIZOTRETA, a structure somewhat analogous to the deltidium is formed between the apex of the pedicle-valve and the opening for the pedicle, and this area becomes modified by the passage of the pedicle over its surface. It is important to distinguish this from the deltidium of the articulate genera, and it may be termed a *listriate deltidium* or *listrium* (lt).



FIGS. 13.— *Orbiculoidea.*

Pedicle valve. Profile. Brachial valve.

V. pedicle-valve; D. brachial valve; *a.* apex of brachial valve; *á* apex of pedicle valve; *f.* foramen; lt. listrium.

It is probably true that in the very early growth stages of all brachiopods, the posterior margin of *both valves* was grooved for the passage of the pedicle. This is to some extent the condition in the adult LINGULA, OBOLUS and OBOLELLA. With the reduction in the relative size of the pedicle, and its restriction to the larger valve, the primitive aperture in the brachial valve was closed by a transverse plate similar in appearance to the deltidium, and in function (to close a discarded or abbreviated passage) to the deltidial plates of the opposite valve. This plate was not formed by the secretion and union of distinct lateral plates but by a

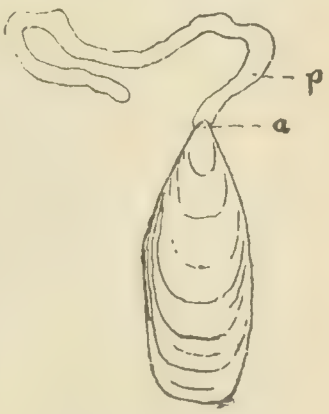


FIG. 14.— *Lingula.* *a.* Apex of pedicle valve; *p.* pedicle.

general deposition about the margins of the aperture from the apex downward. This plate has been termed the *chilidium* (d′) and has been shown to be of secondary growth.

Variations in Form.

The forms assumed by the brachiopods are so diverse that it is often difficult to believe that shells so unlike in contour belong to the same natural group. The habits of these animals and the workings of natural causes in the modification of their shells afford a very substantial aid to the comprehension of these differences.

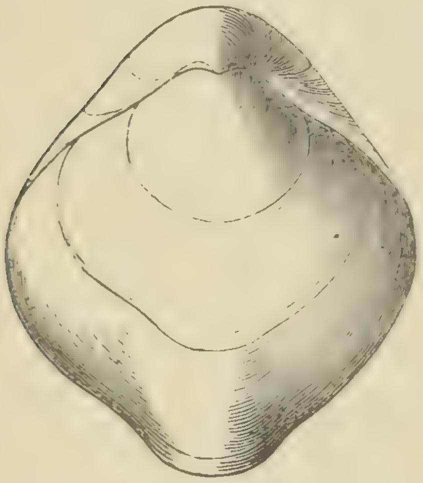


Fig. 15.— *Meristella nasuta.*

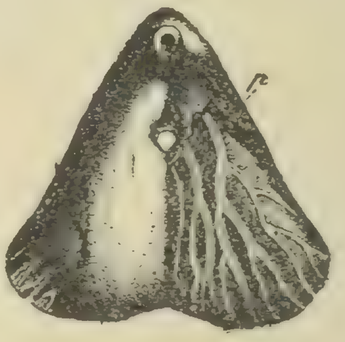


Fig. 16.— *Pygope diphya.*
p. Vascular sinuses.
(Davidson.)

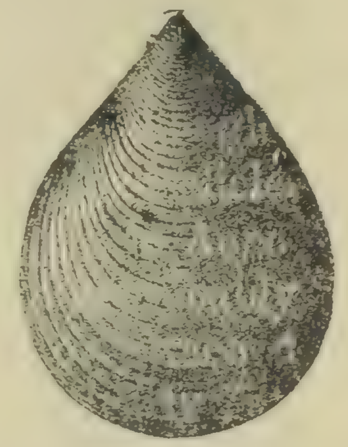


Fig. 17.— *Lingula paliformis.*

The youngest shells of all Brachiopoda (so far as they have been studied) are biconvex and sub-semicircular in outline. Those shells in which the pedicle retains its functions until maturity (Lingula, Terebratula, Magellania, Rhynchonella, etc.) and hang freely suspended from the point of attachment, are oval and biconvex throughout their existence. In such shells as Lingula

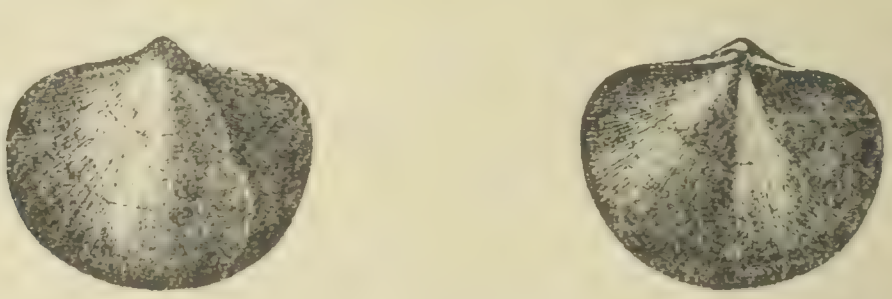


Fig. 18.— *Orthis subcarinata.*

and Obolus, and the early growth stages of many genera where the pedicle is long and flexible, produced in the vertical axis of the animal, and at the same time not restricted in its passage to one valve, the differences in the form of the two valves are at their minimum, as they are more equably exposed and resistant to external physical impacts. Where there is a decided inequality in the valves, it has been observed in living forms, and is probably equably true of fossil species, that the pedicle is short, rigid and restricted to one valve; and there thus appears to be a certain definite relation between the angle at which the pedicle is protruded and the size of the valves. The pedicle-valve, which, typically, in the adult condition is the larger, is the seat of the principal muscular activity and the main lodgment of the viscera; it is, in a certain sense, the cell of habitation of the animal, and

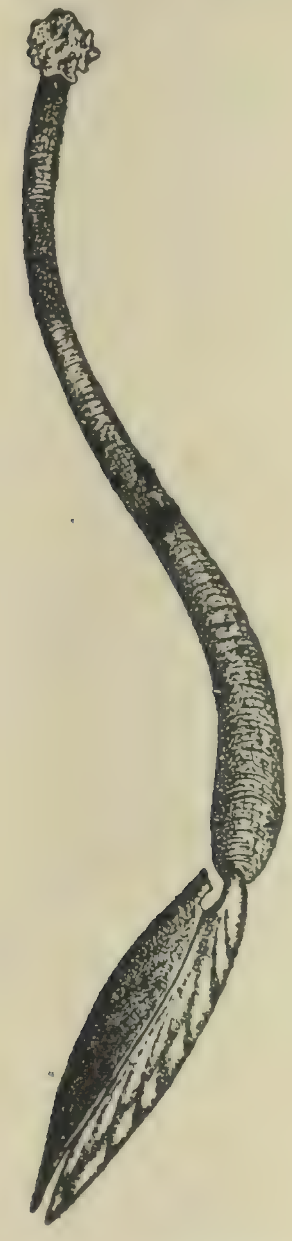


Fig. 19.— *Lingula Murphiana.* (Davidson.)

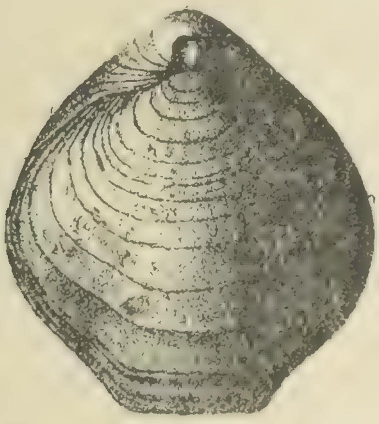


Fig. 20.— *Athyris subtilita.*

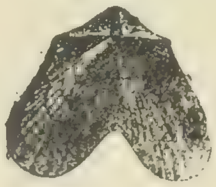
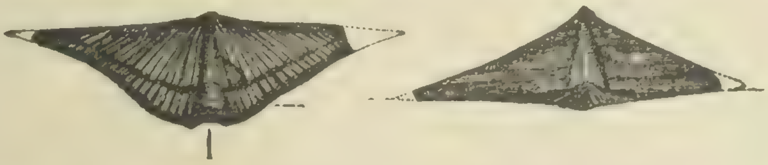
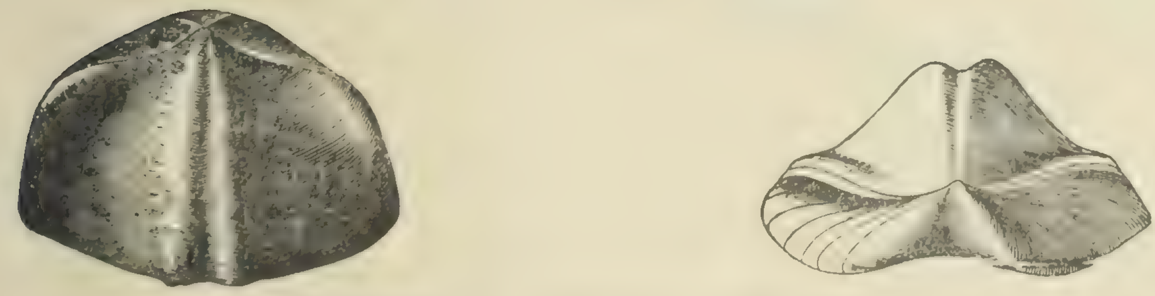


Fig. 21.— *Orthis biloba.*

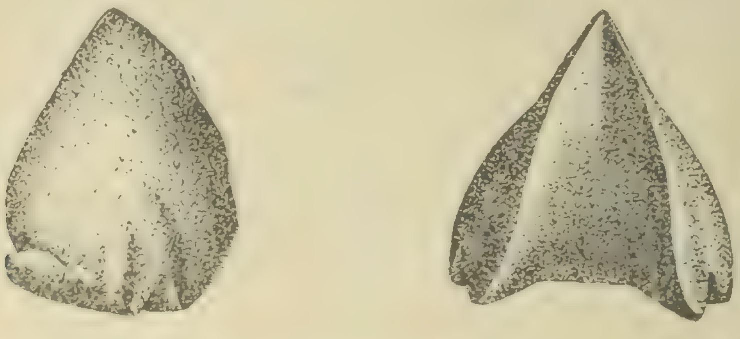


Figs. 22 and 23.— *Spirifer angustus.*



Figs. 24 and 25.— *Pentagonia unisulcata.*

the brachial valve may be compared to an operculum closing it; and in this fact is probably one efficient reason for the differences of size in the two valves.



FIGS. 26 and 27.— *Rhynchonella acuminata.* (DAVIDSON.)

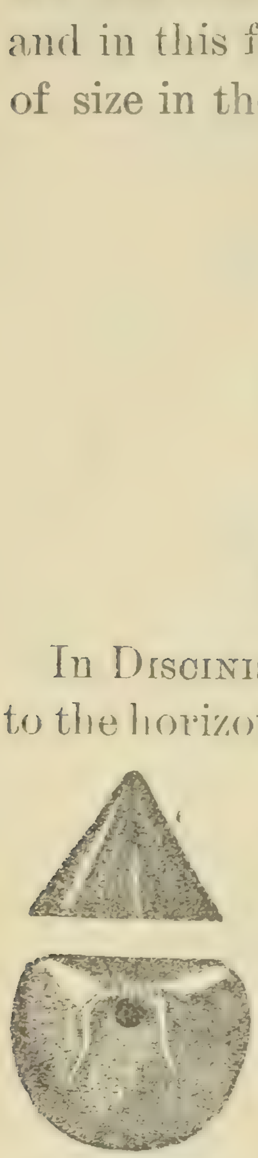


FIG. 28.—*Acrotreta gemma.* The pedicle-valve viewed from the posterior slope and from the apex.—(WALCOTT.)

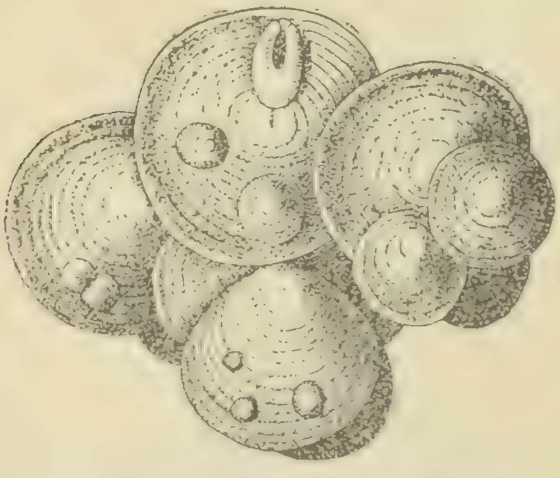


FIG. 29.—A cluster of young and old shells of *Disinisca lamellosa* (SOWERBY).

In DISCINISCA the pedicle is a short plug extending at right angles to the horizontal plane of the valve; and here the lower or pedicle-valve is flat and the upper conical, while in ACROTRETA and CONOTRETA, where the pedicle was probably longer and more flexible, the lower or attached valve is highly conical and the upper nearly flat. As a general rule shells closely attached by a pedicle at this high angle to the plane of the brachial valve have a tendency to circular or subequal peripheral growth (DISCINA, DISCINISCA, ORBICULOIDEA, etc.), and a similar tendency is manifested in shells attached by solid cementation, not only in CRANIA, CRANIELLA, etc., which are hingeless genera, but also such genera as are provided with a hinge, when attached, evince a spreading or ostrean form of growth. Articulate shells, where the pedicle has maintained its function during a considerable portion of the period of adolescence (some species of SPIRIFER, CYRTINA, ATHYRIS, STROPHOMENA, LEPTÆNA, etc.), but later becomes atrophied, so that the animal must have dropped from its support and fallen upon the sea-bottom, are found to combine an elongate form with considerable breadth of hinge, and often with a highly developed cardinal area. In the Oriskany sandstone of Cumberland, Maryland, has been found a fragment of a valve of

Spirifer arenosus, to which are attached a number of the young of *Cyrtina rostrata*, in their original position. The specimen shows that attachment by the pedicle in spiriferoid shells brought the cardinal area close and flat against the surface of adherence, the pedicle evidently having been extremely short. In such close attachment, obstructing, from the first, additions to to the posterior margin of the shell, may be suggested an explanation of the origin of the cardinal area and extended hinge.

In concavo-convex species, as of STROPHEODONTA, PRODUCTUS, PLECTAMBONITES, etc., the pedicle was evidently atrophied very early in the history of the individual. Some such shells, as RAFINESQUINA and LEPTÆNA, at times retain at maturity, a slight external evidence of a foramen, or the foraminal passage may even remain open as a minute puncture, but in this condition no sufficient number of muscular fibres could have passed through it to have supported the shell. Such shells, in becoming freed from the surface to which they were attached, would fall upon the sea-bottom, the heavier or pedicle-valve down, so that virtually this still acted as the attached valve. It will readily be understood that the contour of these concavo-convex shells is a necessary result of an obstruction to the marginal growth of the brachial or concave valve, by the more rapid growth of the pedicle-valve.

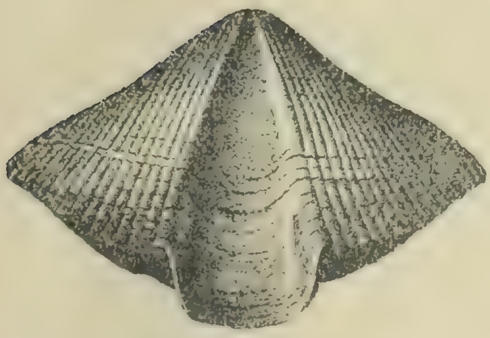


FIG. 30.—*Spirifer asper.*

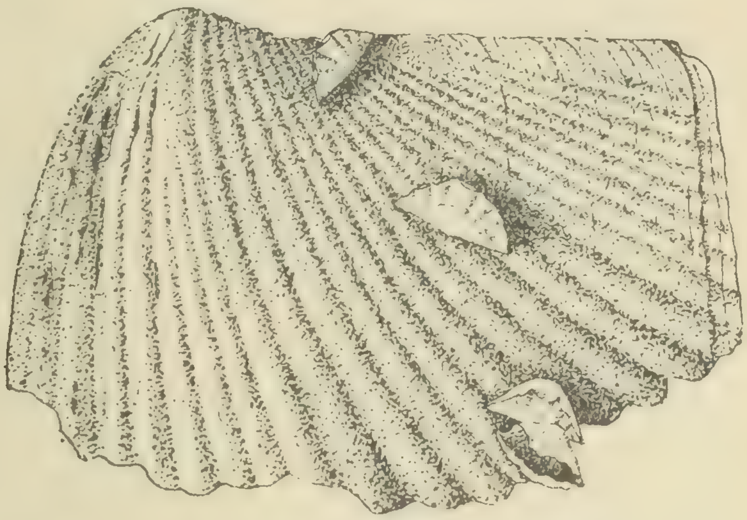


FIG. 31.—Young of *Cyrtina rostrata* attached by the face of the cardinal area to the surface of *Spirifer arenosus.* Oriskany sandstone, Cumberland, Md.

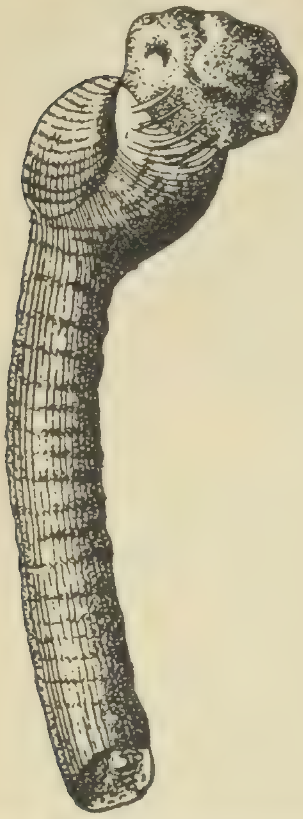


Fig. 32.— *Proboscidella proboscideus* (Etheridge).

In many of these shells the pedicle-valve was provided with spines serving to attach it more firmly to its place in the sediment, so that it became less liable to be washed from its position; and among such spiniferous shells we find the greatest convexity of this valve, and often a remarkable extension of its anterior margins (Productus). In *Productus* (*Proboscidella*) *proboscideus* and *P. Nystianus*, this modification is carried to an extreme, the pedicle-valve being greatly produced at its free margins which meet on the lower side and form a long tube, while the brachial valve is small, unmodified and operculiform. It has been suggested that the function of this modification is to transmit water to the animal deeply buried in the sediments.

An opposite extreme of form occurs in certain nearly plane species of Stropheodonta (Leptostrophia; plate 15, figs. 1–4), in which the two valves have maintained an equable growth for their entire extent.

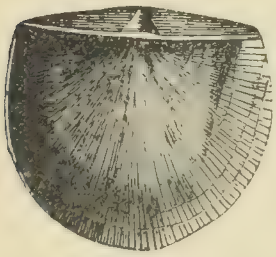


Fig. 33.—*Strophomena deltoidea.*

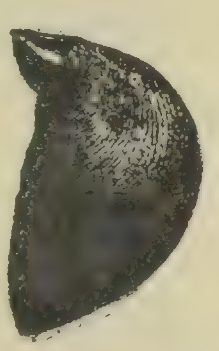


Fig 34. — *Strophomena Wisconsinensis* Profile view showing the convexity of the brachial valve and the concavity of the pedicle-valve in the umbonal region.

There are a few shells of this concavo-convex group, whose valves have a double curvature. Thus in Strophomena, Strophonella and Chonostrophia, the contour of the two valves in youth, or in the umbonal region of adult shells, is normal, the pedicle-valve being convex, the brachial concave; but in later growth this contour becomes reversed, and the general concavity of the shell is on the pedicle-valve and its convexity on the brachial valve. The causes of such reversion in contour can only be due to an accelerated growth of the brachial valve after the early stages have been passed; and it may be observed that species of Strophonella are all, virtually, reversed Stropheodontas. Stropheodonta is a genus which in its adult state, at successive periods in its history, exhibits in a most remarkable manner various phyletic developmental phases. Thus its earlier (Silurian) representatives

(Brachyprion) have the delthyrium either open or partially closed by a convex deltidium, and the crenulations of the hinge-line restricted to the immediate vicinity of the delthyrium. Gradual progress in these features is observable throughout the late Silurian and early Devonian species; and in the middle or later Devonian when the genus disappears, the species have the delthyrium completely closed, the outlines of the deltidium obliterated and the crenulation of the hinge extending to the cardinal extremities. There is corresponding progress in the development of the internal features. With each phase of Stropheodonta there is, in the same fauna, a corresponding phase of the reversed shell Strophonella. In a certain sense the genera Rafinesquina and Strophomena bear a similar relation to each other, both appearing and disappearing in geological history at about the same time.

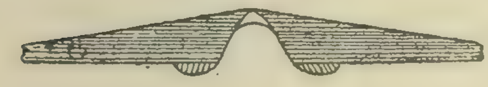


Fig. 35.— The cardinal area of *Stropheodonta (Brachyprion) Leda*; showing the few crenulations on the cardinal margin near the delthyrium. Clinton group. (Billings.)

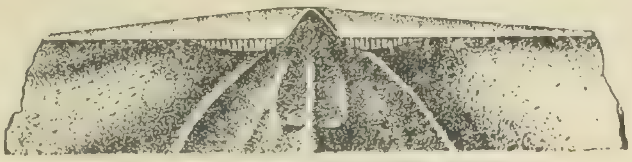


Fig. 36.—The cardinal area of *Stropheodonta (Brachyprion) profunda*, with more numerous cardinal crenulations. Niagara group.

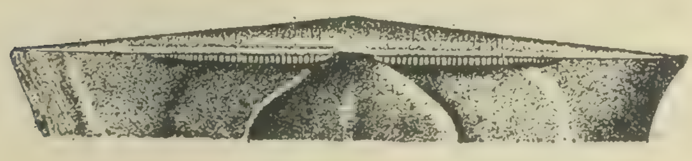


Fig. 37.—The hinge area of *Strophonella ampla;* showing the extension of the cardinal denticulations for about one-half the length of the hinge-margin.

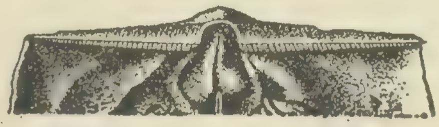


Fig. 38.—The cardinal area of *Stropheodonta demissa*, with the crenulations extending to the extremities of the hinge.

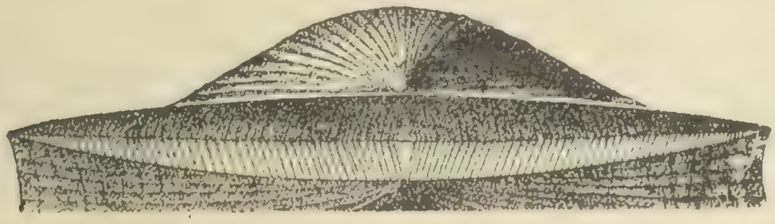


Fig. 39.—The cardinal areas of *Stropheodonta demissa*; showing the closed delthyrium.

Ornamentation of the External Surface.

The surface of the brachiopod shell is rarely entirely smooth. It may bear only the concentric lines or varices of growth, and sometimes squamous, lamellar expansions, but as a general rule, the surface is covered with radiating striae, lines, plications or ribs, which may either be of equal size, may alternate in size, or be arranged in fascicles. Such configuration is of secondary growth, the incipient shell being free from it, except in rare instances where evincing an acceleration of development in this respect, or in other words, an earlier inheritance of specific characters. In the plicated shells, the plications of one valve generally alternate in position with those of the other, so that on the margins, the edges of the two series are interlocked, effecting complete closure.

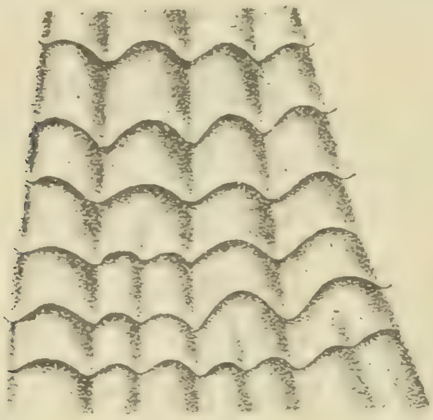


Fig. 40.—The lamellose surface of *Atrypa aspera.*

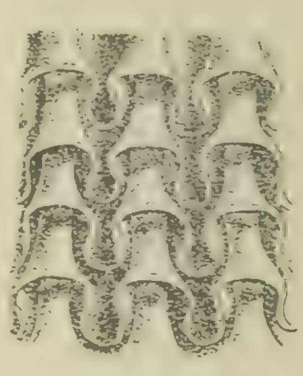


Fig. 41.—The concentric lamellæ of *Atrypa imbricata*; enlarged. (Davidson.)

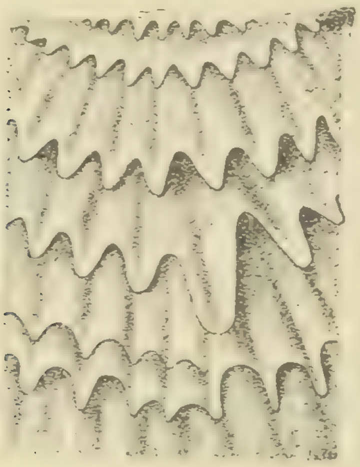


Fig. 42 —A portion of the exterior of *Atrypa reticularis*; showing the extension of the lamellæ and their tendency to fold upward into hollow spines.

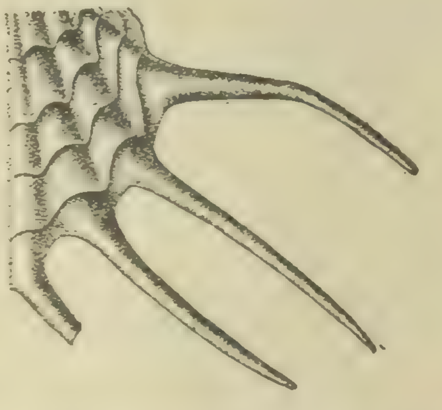


Fig. 43.—The surface spines of *Atrypa hystrix.*

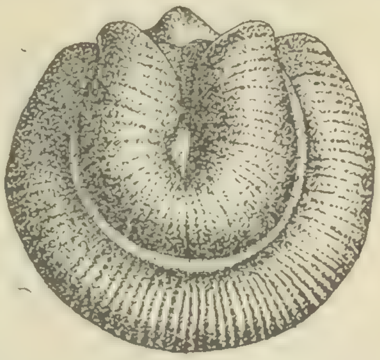


FIG. 44.—*Productus tesselatus,* viewed from the brachial valve; showing the curved fringes. (DAVIDSON.)

The concentric lines when not wholly superficial may be regarded as representing periodic interruptions in the outward expansion of the mantle. In some genera, as ORBICULOIDEA, DISCINISCA, TRIMERELLA, etc., there are frequent irregular lamellose expansions of the outer shell layer, which produce a rough, squamous exterior (Plates 5, 6.). In species of ATHYRIS, ATRYPA, and, rarely, PRODUCTUS, there are regular expansions at the concentric lines, which are sometimes extravagantly extended (*Athyris concentrica*, *A. planosulcata*, *A. lamellosa*, *Atrypa reticularis*, etc.); in other species the concentric lamellæ become divided into a fringe of flat, hollow spines. Again, in SIPHONOTRETA, ATHYRIS, and SPIRIFER, there are rows of hollow, round spines, which are sometimes divided by a median partition (*A. hirsuta*) and may be compound, with pinnate lateral branches. (*S. fimbriatus.*) (See Plate 25, fig. 12). When the spines are irregularly scattered over the surface they are generally of larger size. This is preeminently the case in PRODUCTUS, where the spines are often of great size and remarkable length. Such spines could never have been flexible, but they were frequently a means of attachment to foreign bodies, whether by cementation as in STROPHALOSIA, or by anchoring in the sediment.* In the younger conditions of such spiniferous shells the spines have, to some extent, opened into the inner cavity of the shell, but in later growth they became, for the

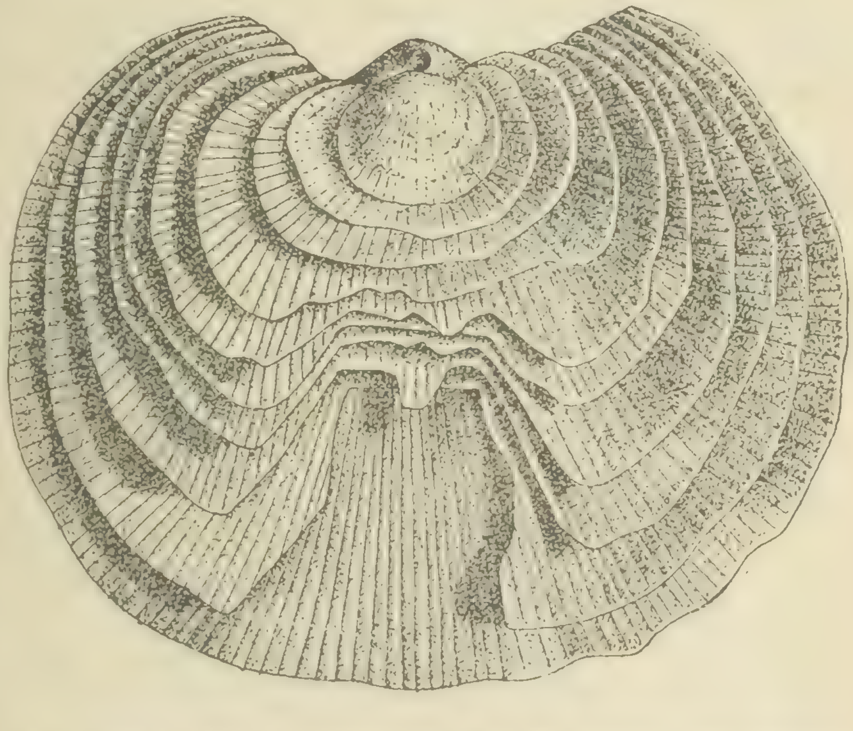


FIG. 45.—*Athyris planosulcata,* with its marginal expansions. (DAVIDSON.)

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* It has been stated by YOUNG that in some species of PRODUCTUS the large spines appear to be furnished on the interior with a multitnde of spinules standing convergent to the axis of the spine. This observation has not yet been verified by others.

most part, closed. This statement, however, is not true of Chonetes where there is a single row of short marginal spines on the cardinal margin of the pedicle-valve alone; these cross the cardinal substance of the valve, have wide, internal openings and are believed to be closed at their outer extremities. In Anoplia these tubular passages exist, but are not extended into spines (see Plate 20, figs. 15-19). Some species of Siphonotreta and Strophalosia have the spines corrugated. In a few genera the cuticular or outer layer of the shell bears a reticulated or tesselated ornament, or series of coarse punctures arranged in quincunx (Trematis, Eichwaldia, Porambonites), or in radial rows (Orthis, Porambonites; Plate 6). The surface is often granulose, especially in species which possess a punctated shell, and sometimes in other shells, as Spirifer. The genus Leptæna is characterized by coarse concentric wrinkles or undulations over the horizontal or visceral area of the valves; rarely there are two series of fine oblique concentric wrinkles, as in Chonopectus. It has been observed that the greatest modifications of the exterior occur on the pedicle valve, and this difference may be largely explained by comparing the brachiopod with the bryozoan. If the brachial or upper valve of the former corresponds to the operculum of the latter, it is then the pedicle-valve which, as above suggested, may be regarded as the cell or main receptacle

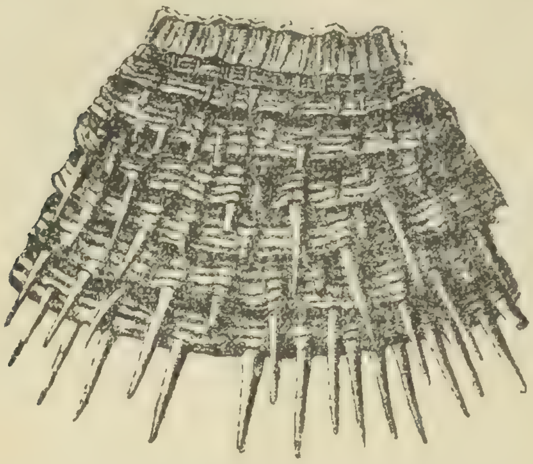


Fig. 46.—Portion of the shell of *Siphonotreta*; enlarged. (Kutorga.)

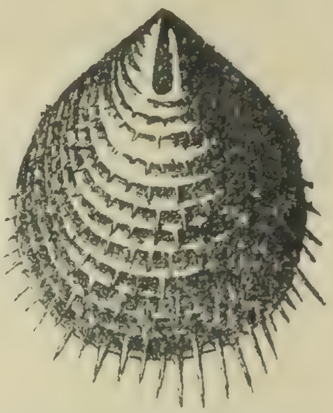


Fig. 47. — *Schizambon fissus*. (Kutorga.)

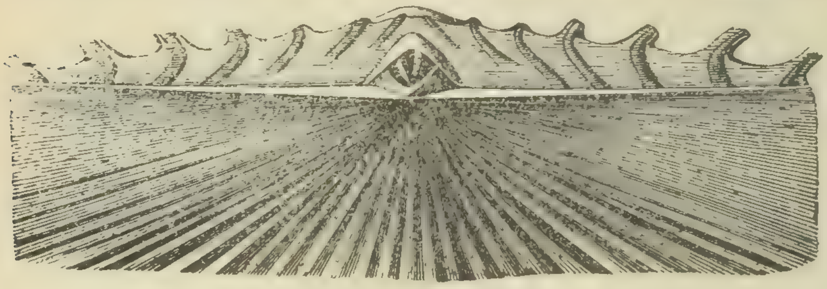


Fig. 48.—*Chonetes scitula*. Showing the tubes connecting the hollow marginal spines with the interior of the shell; enlarged.

of the animal, and is therefore more highly specialized and more susceptible to variation in its external form.

Cardinal area.— In many of the dentiferous or articulate brachiopods a conspicuous feature of the shell is the specialization of the posterior portion of the pedicle valve as a vertical or curved triangular area. The same character is sometimes present on the brachial valve, though less highly developed. In genera, which have a straight or extended hinge-line, this area attains its most conspicuous development. It does not bear the ornamentation of the rest of the external surface, but is smooth, or with horizontal lines of growth crossed by vertical lines of structure.

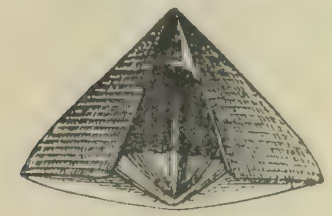
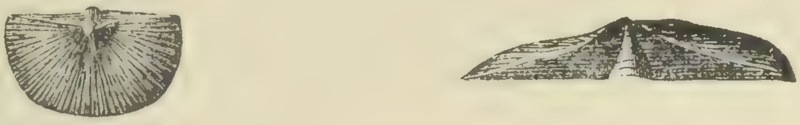


FIG. 49. — Cardinal area of *Scenidium insigne*; enlarged.



FIGS. 50 and 51.—*Orthothetes arctostriata*; showing cardinal area and deltidium.

It has already been suggested that this area probably originated from the close attachment of the animal by its pedicle, which obstructed the outward growth of the valves. The intimate structure of this portion of the shell does not, however, differ materially from that of the remainder. In forms which were evidently suspended freely throughout their later existence, by a moderately long arm, this area does not exist (TEREBRATULA, RHYNCHONELLA, etc.), and this may be due to the fact that the posterior growth of the valves was unobstructed by close adhe-

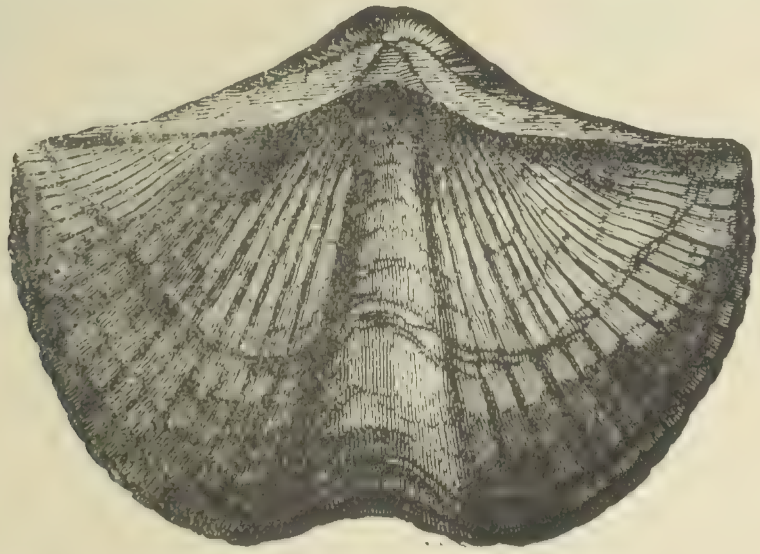


FIG. 52.— *Spirifer granulosus*; showing the cardinal area.

sion to the object of support. Among the edentulous genera there is rarely the least indication of such an area. In Acrotreta, Conotreta, Acrothele, Iphidea, etc., where the foramen is apical there is a posterior flattening of the pedicle-valve, upon which the concentric ornamentation of the shell is retained. This has sometimes been inaccurately termed a "false cardinal area," or a "pseudo-area." Though not so sharply defined as the cardinal area in the articulate brachiopods, it is nevertheless an homologous structure and needs no other designation. In such genera as Discinisca, Orbiculoidea, etc., there was no obstruction to the posterior growth of the shell, and therefore no cardinal area.

The Delthyrium and its Coverings.

By the term *delthyrium* is meant the median triangular fissure or cleft which crosses the cardinal area of the pedicle valve; or when that area does not exist, traverses the posterior surface from apex to cardinal line. It is the passage for the pedicle, and always subserves this function when existing in an uncovered condition in adolescent or mature growth. In Orthis this is its normal condition at maturity; but it has been shown that the open delthyrium at this stage, in *Orthis varica*, is actually a modified phase, the shell having assumed in youthful growth a convex covering or deltidium, which is subsequently resorbed. In Schizocrania the triangular slit is retained in all stages of growth, and in Trematis its outer edges converge at maturity, while in Orbiculoidea it is altogether a feature of early growth, the adult shell having the passage closed by the union of the edges on the posterior margin, and the contemporaneous formation of a transverse plate or *listrium* beneath the apex. In the inarticulate genera Iphidea and Vol-

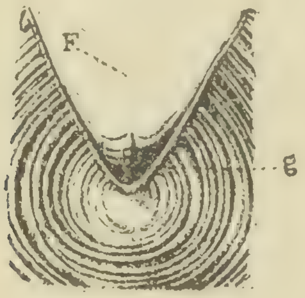


Fig 53.—Pedicle passage of *Schizocrania filosa*. *F*, triangular pedicle fissure; *g*, listrum.

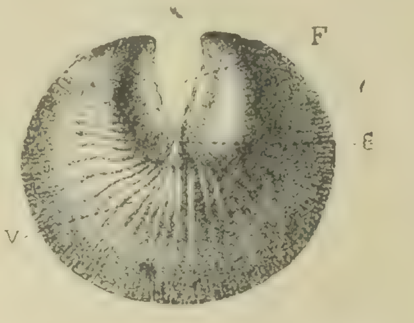


Fig. 54.—*Trematis treminalis*. Interior of pedicle-valve. *F*. foramen; *v*, vascular sinuses; *g*, pedicle-groove.

BORTHIA the place of the delthyrium is covered by a convex ridge; in ACROTRETA and CONOTRETA there is a groove instead of a ridge.

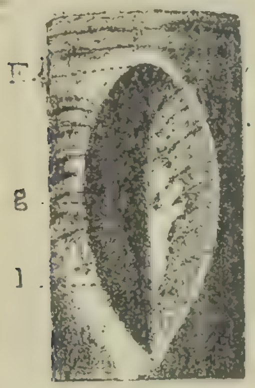


FIG. 55.—Pedicle-groove of *Orbiculoidea tenuilamellata* *F*, foramen; *g*, base of groove; *l*, walls of groove.

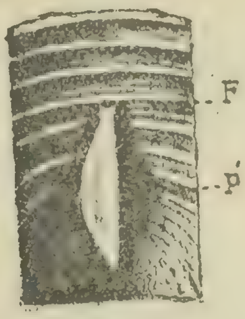


FIG. 56.— Pedicle-area of *Orbiculoidea Herzeri* viewed from within. *F*, foramen: *p′*, under surface of listrium.

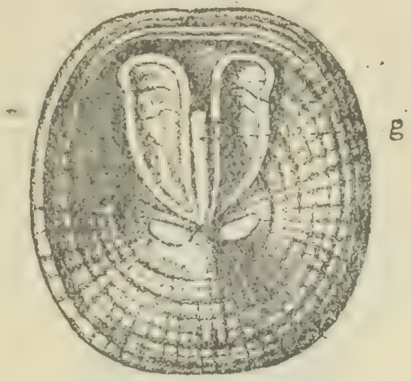


FIG. 57 —Interior of pedicle-valve of *Orbiculoidea nitida*. *F*. foramen; *g′*, inner surface of pedicle-groove or listrium. (DAVIDSON.)

The convex ridge or plate which has been termed the *deltidium* in the articulate brachiopods is retained in many genera at maturity (PROTORTHIS, BILLINGSELLA, STROPHEODONTA, STROPHOMENA, LEPTÆNA, ORTHOTHETES, DERBYA, etc., etc., Plates 8, 13, 19) and it usually exists in all species which have the cardinal area developed. That it is not always retained may be due to different causes. Its union with the margins of the delthyrium are lines of weakness along which it is often readily separated from the valves; it may be gradually abraded or become resorbed by the animal.

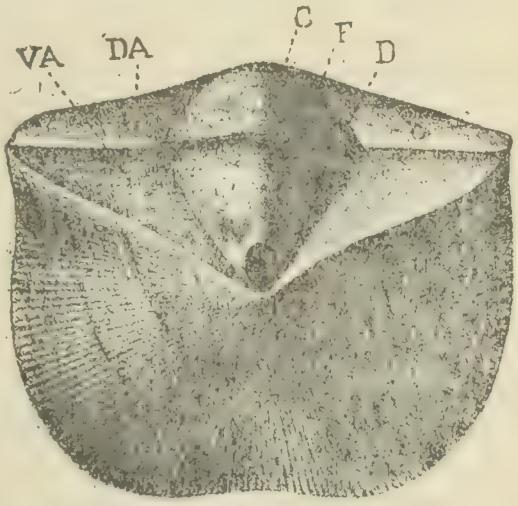


FIG. 58.— *Clitambonites* (*Orthisina*) *anomala*. VA, cardinal area of pedicle-valve; DA, cardinal area of brachial valve; D, deltidium; C, chilidium; f, foramen. (DEVERNEUIL.)

In some of the dentiferous genera in which the cardinal area is very obscurely defined and the umbo of the pedicle-valve closely incurved (PENTAMERUS, AMPHIGENIA), the deltidium is concave, and the pedicle probably not functional at maturity.

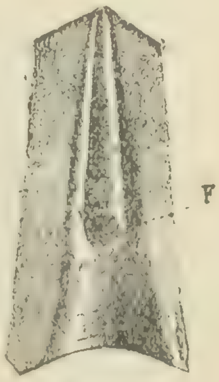
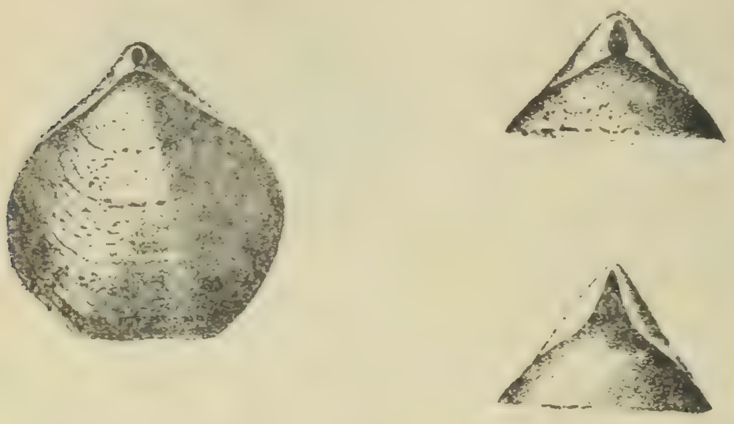


FIG. 59. — Deltidium of *Cyrtina*; F, foramen. (DAVIDSON.)

In most of the articulate genera, however, such as TEREBRATULA, RHYNCHONELLA and their allies, MERISTA, MERISTELLA, RETZIA, etc., etc. the covering of the delthyrium consists of two convex plates formed by gradual growth along the margins of the opening and uniting in the median line; bounding the lower side of, or encircling the pedicle. Various stages in the development of these *deltidial plates* are attained at the maturity of different species. (Plate 23, figs. 11 and 12.) Thus, in *Meristina rectirostris* they are but feebly, if at all developed, evincing either the embryonic or degenerate character of the adult in this respect; while in *Eumetria Verneuiliana* they are closely united by coalescence from the apical foramen to the hinge and their convexity wholly obliterated.



Figs. 60, 61, 62.—*Whitfieldella nitida*; showing the progressive closing of the deltidium by the growth of the deltidial plates. The figures at the right represent immature conditions, that at the left the adult state.

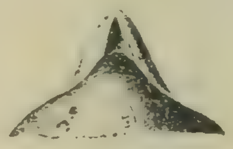


Fig. 63.—The adult condition of the delthyrium in *Meristina rectirostra*, showing the absence of deltidial plates.

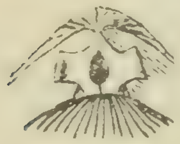


Fig. 64.—*Rhynchonella Grasiana.* showing the extravagant growth of the deltidial plates in the adult. (Deslongchamps.)

With present evidence, these deltidial plates appear to be a secondary modification of the delthyrium, induced after the disappearance of the original covering of this passage from the causes already suggested.

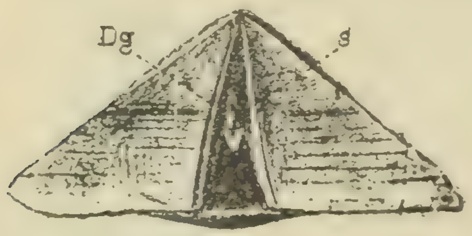


Fig. 65.—A cardinal view of *Spirifer asper*; showing the callosity in the delthyrium.

In many of the articulate genera the delthyrium, if left open either from resorption of its normal coverings or from a failure to develop them, becomes filled by a progressive secretion of testaceous matter in the later stages of growth. This is especially marked among a certain group of the Spirifers where this callous growth forms a more or less complete transverse plate; and the extreme result of this development is exhibited by the genus Syringothyris, in which this condition of hypertrophy in the shell glands, produces not only a complete transverse plate covering or partial filling of the cavity extending from the apex nearly to the basal margin of the delthyrium, but also builds up on the inner side of this plate a tubular sheath, open along its ventral surface and which probably inclosed the atrophied pedicle of the animal. This peculiar tubular structure may be termed the *syrinx*.

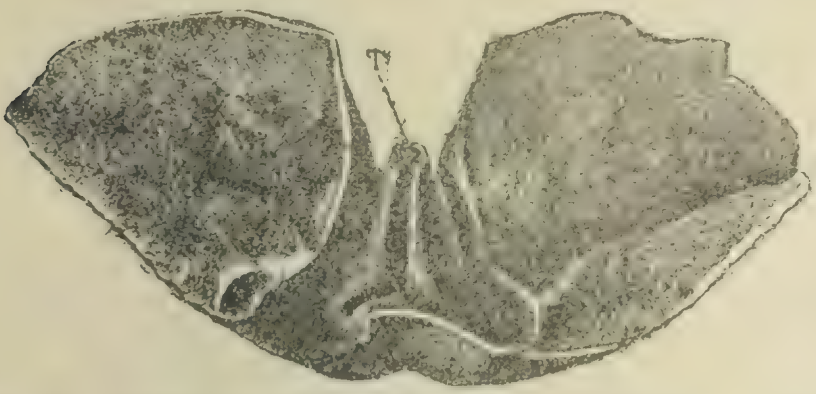


FIG. 66.—Interior of pedicle-valve of *Syringothyris*. T, the split tube or syrinx.

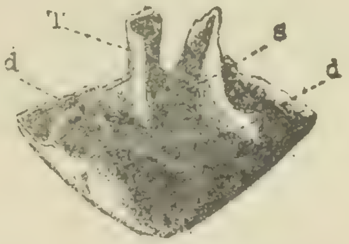


FIG. 67.—*Syringothyris typa*. The interior of the umbonal portion of the pedicle-valve, showing the split-tube or syrinx attached to the transverse plate filling the delthyrium.

The covering of the delthyrium in the brachial valve (*chilidium*) which is always a single plate is of later growth than the deltidium, and is therefore not a primitive structure.

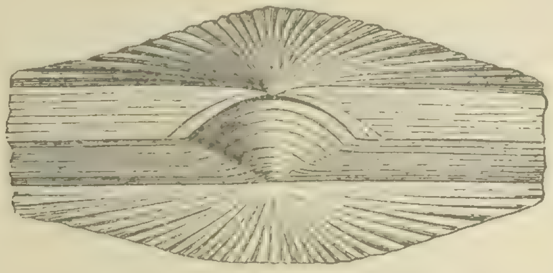


FIG. 68.—Cardinal view of a portion of the valves of *Orthothetes subplana*; showing a remarkable development of the chilidium.

THE INTERNAL CONFIGURATION OF THE VALVES.

Articulating Apophyses.

Articulation of the valves is mainly effected by means of *teeth and sockets*, the former on the pedicle-valve, the latter on the brachial valve. In inarticulate genera the valves are usually held in apposition simply by muscular contraction, and seldom is any tendency to the formation of articulating processes manifested. Occasionally low bosses are formed on the cardinal margin of the pedicle-valve (TRIMERELLA, BARROISELLA, TOMASINA; Plate 1, fig. 14), which probably subserved to a certain extent the purposes of a hinge. In the articulates the teeth lie at, or just beneath the cardinal margin, and at either side of the delthyrium. They are short processes, free at their extremities, which are frequently curved upward or backward into their sockets in the opposite valve, thus locking the valves in such a manner that it often becomes impossible to separate them without breaking the teeth. Both teeth and sockets vary considerably in their development in different genera, and in different species of the same genus, but they are invariably two in number and are always constructed on the same plan.

Articulation is also aided by the *cardinal process*, an apophysis situated at the center of the hinge of the brachial valve, and which in certain extinct genera, as Stropheodonta, Derbya, Nucleospira, Productus, Stringocephalus, is of a very considerable size. This process was a surface of attachment of certain muscles, which, by their contraction, opened the valves, and its size is due to the fact that testaceous matter has been rapidly secreted about the extremities of the muscular bands. It is in the later stages of growth that the cardinal process obtains notable size, and that usually in species where the pedicle has become atrophied and is no longer an obstacle to its growth. The posterior surface of this process, which was the surface of muscular attachment, is variously lobed, furrowed or striated. (Plates 9–22.)

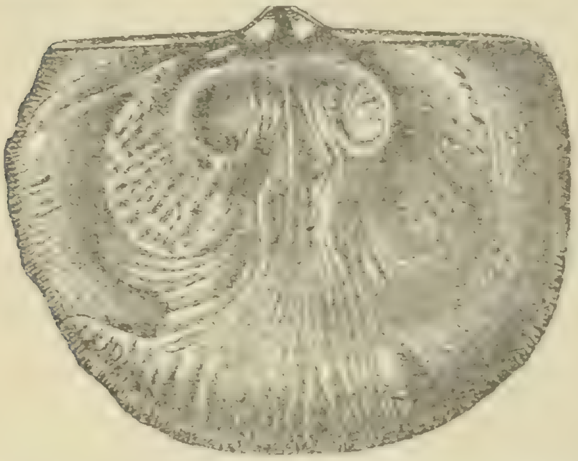


Fig. 69.—*Rafinesquina alternata.* Interior of the brachial valve.

The cardinal process is frequently connected with, and often merged into, an elevated central *hinge-plate.* This plate is not found in genera where the cardinal process attains its highest development (Strophomena, Derbya, Orthothetes, Triplecia; Plates 16, 17 and 18), but, rather in those whose brachia are provided with calcified supports (Meristella, Retzia, Athyris, Terebratula, etc.), and while it is in some degree a surface of muscular attachment, it also serves as a support to the bases of the brachia (*crura*).

The inner margin of the hinge in both valves frequently bears a series of fine, interlocking denticulations, making an arrangement which contributes to the firmer union of the valves (Stropheodonta, Spirifer, etc.). Interlocking plications about the lateral and anterior margins of the valves serve a similar end.

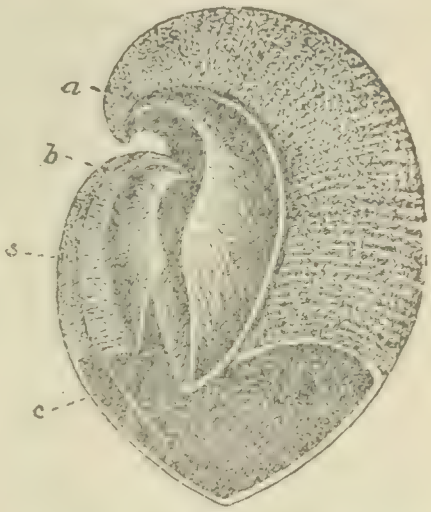


Fig. 70.—*Conchidium Knighti.* Longitudinal section, showing the septa (*s*) and spondylia (*a*, *b*) of both valves, and the crura (*c*). (Davidson.)

Septa.

Vertical plates or *septa* divide the interior cavity of the valves of some genera in various ways. The teeth are frequently supported by such plates, one on each side of the delthyrium of the pedicle-valve, and these are known as *dental plates.* Such plates may rest upon the inner surface of the valves or converge and unite, forming a spoon-shaped process, or *spondylium*, which is sometimes free, except at its posterior margin, but is usually supported by a *median septum* (Clitambonites, Pentamerus, Camarophoria, etc.). When the spondylium is not present in the pedicle-valve, a median septum often divides the muscular region and itself becomes a surface of muscular attachment (Enteletes, Spiriferina). There may also be one or more *lateral septa* on each side of the median one, as in the genus Polytœchia (Plate 8, figs. 16–20); this, however is of rare occurrence.

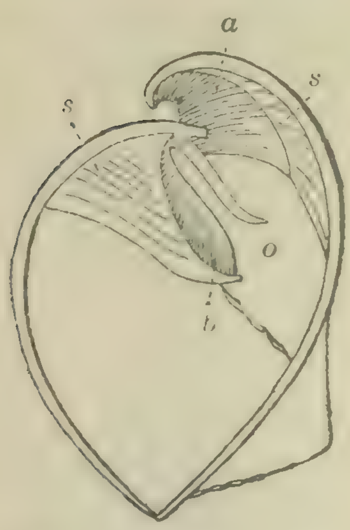


Fig. 71.—*Camarophoria Schlotheimi.* *s*, median septa; *o* crura; *a*, spondylium of pedicle-valve; *b*, spondylium of brachial valve. (Woodward.)

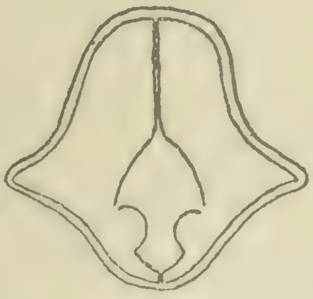


Fig. 72.—*Sieberella Sieberi.* Transverse section showing the spondylia supported by median septa.

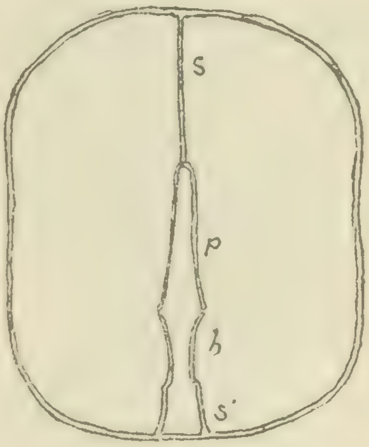


Fig. 73.—Transverse section of *Conchidium Knight.* *s*, median septum of pedicle-valve; *s'*, septa of brachial valve; *p*, spondylium of pedicle-valve; *b*, crura, plates.

In the brachial valve the *crura* or bases of the brachial processes may be supported by divergent vertical septa, known as the *crural plates.* These may also converge and form a spondylium. Accompanying these, or independent of them, may be a prominent median septum (Enteletes, Kayserella, Pentamerus); and the latter may support the spondylium. There may also be two parallel median septa supporting the convergent, but not united crural plates (Barrandella, Pentamerus, Conchidium). In the inarticulate genera the median and lateral septa are sometimes well developed, but do not often attain great size (Lingula, Dignomia, Glottidia, Lingulasma, etc.).

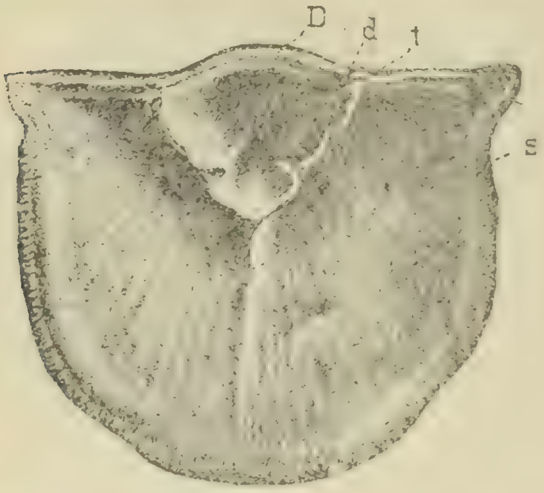


Fig. 74.—Interior of pedicle-valve, of *Orthisina anomala* D, deltidium; *t*, teeth; *d*, dental plates, forming a spondylium; *s*, median septum. (Davidson.)

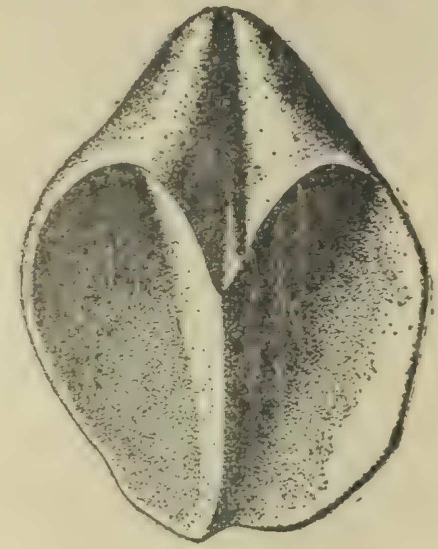


Fig. 75.—The interior of the pedicle-valve of *Conchidium;* showing the spondylium.

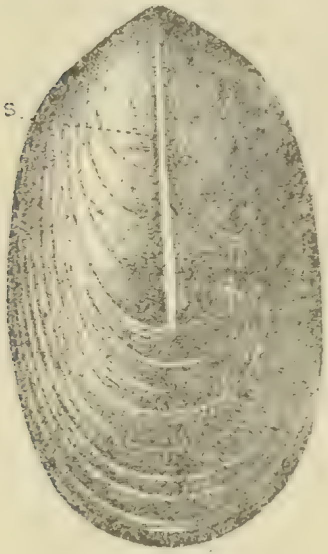


Fig. 76.—*Lingula Delia,* with median septum (*s*).

Muscular scars.

The impressions made upon the shell by the attachment of the muscles are usually confined to the umbonal and posterior portions of the valves. There are some exceptions to this rule, as in the case of *Hipparionyx proximus* and a few members of the orthoid genus Rhipidomella, where the great scars of the pedicle-valve extend almost to the anterior margin of the shell. The impressions of the several muscular bands are retained with various degrees of distinctness; among the fossils they are often merged with one another, so that only the outline of the muscular area, as a whole, is visible. Among the articulate genera one plan of arrangement is maintained without essential modification. In the middle line of the pedicle-valve is a narrow oval impression of the *adductor muscle*, which is divided medially into two scars; at the sides are two pairs of scars, the larger in front (*diductors*), the smaller behind (*pedicle-muscles*).

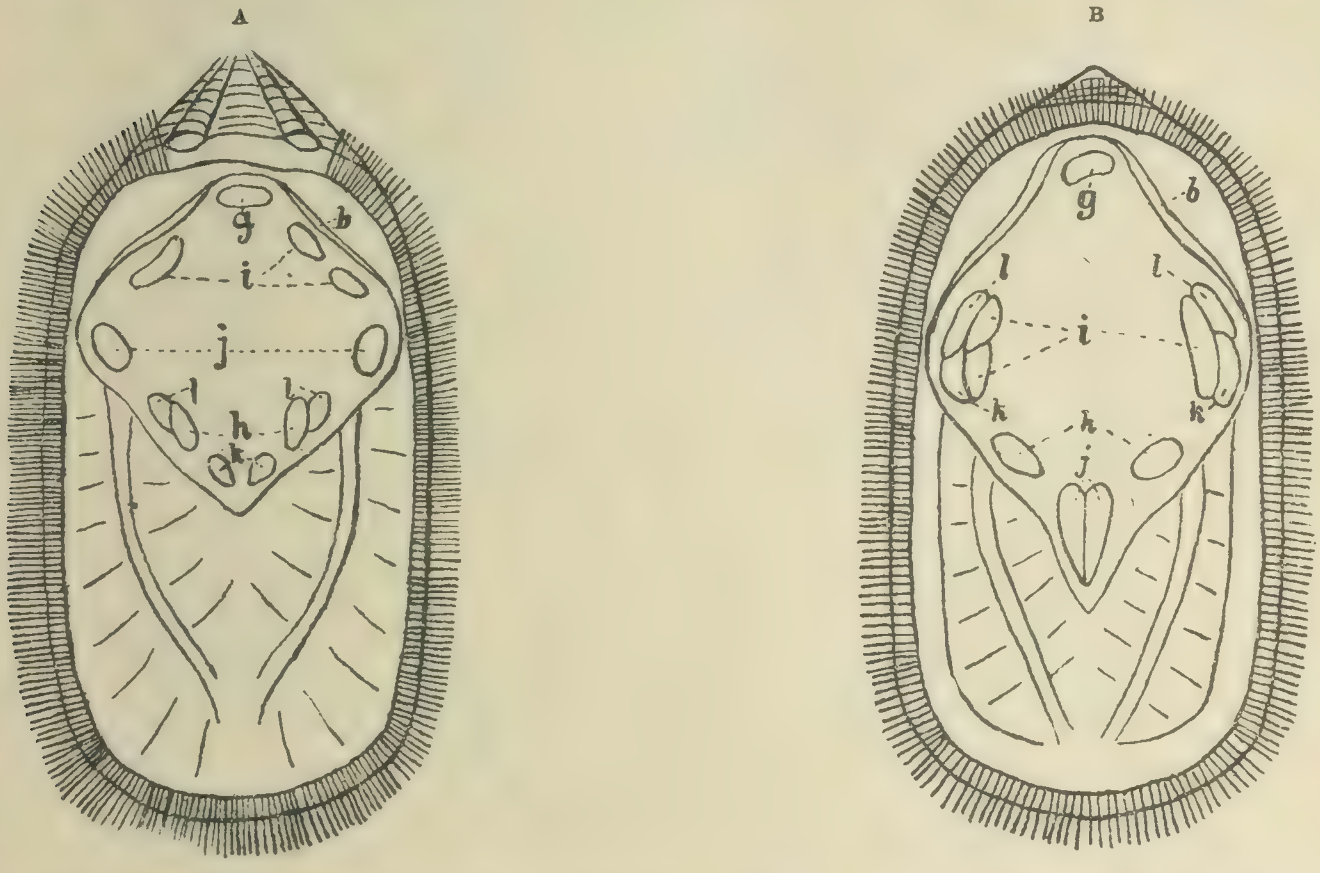


Fig. 77.—Muscular system of *Lingula anatina*: A, pedicle-valve; B, brachial valve; *b*, parietal scar; *g*, umbonal muscle; *i*, transmedians: *h*, centrals; *j*, *k*, *l*, laterals (*j*, anteriors; *k*, middles: *l*, externals). (Davidson.)

Occasionally the scars of a small *accessory* pair of *diductors* are found just behind the adductor scars; and behind these is an

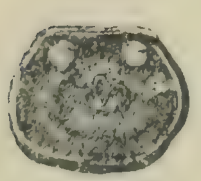
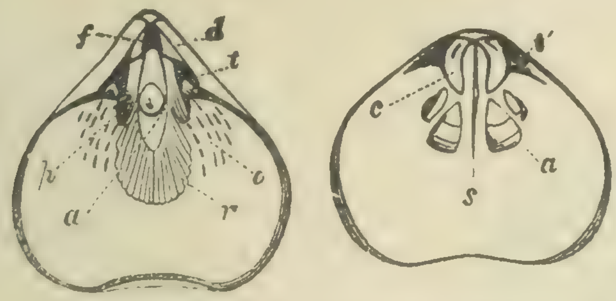


Fig. 78.—*Craniella Hamiltoniæ.* The attached valve, showing the anterior and posteror adductor scars.



Figs 79, 80.—Interiors of the pedicle and brachial valves of *Rhynchonella (Hemithyris) psittacea; f*, foramen; *d*, deltidial plates; *t*, teeth; *t′*, dental sockets; *p*, pedicle muscle; *a*, adductors; *r*, diductors; *o*, ovarian markings; *c*, crura; *s*, septum.

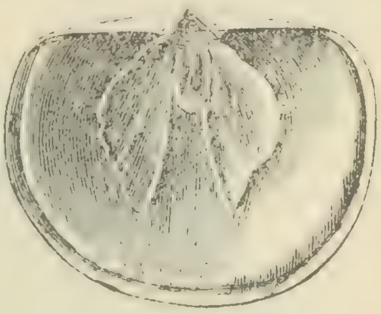


Fig. 81.—Interior of the pedicle valve of *Orthis Clytie*, showing the pedicle, adductor and diductor scars.

undivided scar of the *pedicle-muscle.* In the brachial valve there are four undivided adductor scars in two distinct pairs, one the *anterior*, the other the *posterior* pair. This arrangement of the scars is very simple compared with that found in some of the inarticulate genera (LINGULA, DISCINISCA), but among the fossil species of such genera the muscular impressions are rarely retained with distinctness. For the fuller elucidation of this subject the student is referred to the chapter on the MUSCULAR SYSTEM.

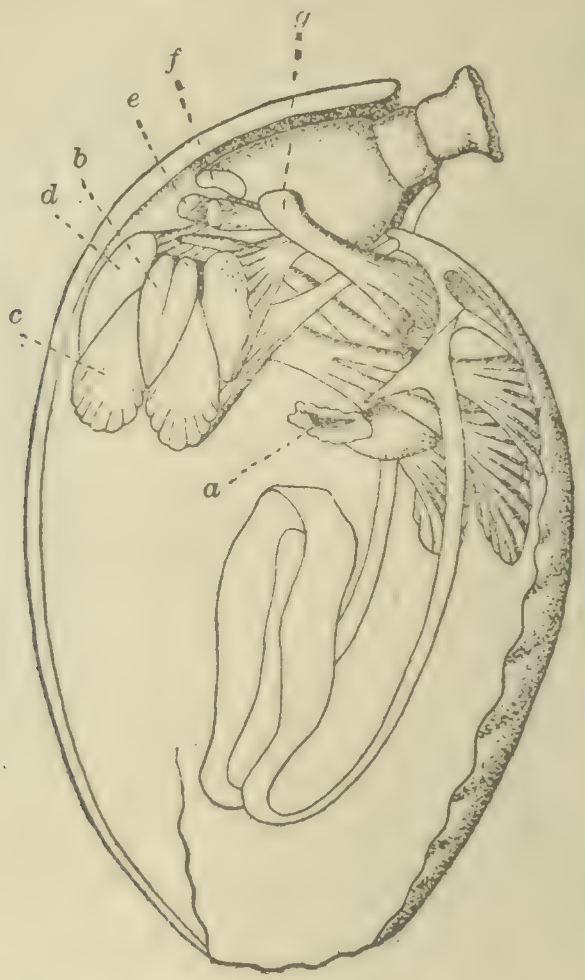


FIG 82.—Muscular system of *Magellania australis.* *a*, mouth; *b*, adductors; *c*, diductors: *d*, ventral pedicle muscles: *e*, accessory diductors; *f*, median pedicle muscle; *g*, dorsal pedicle muscle. (WOODWARD.)

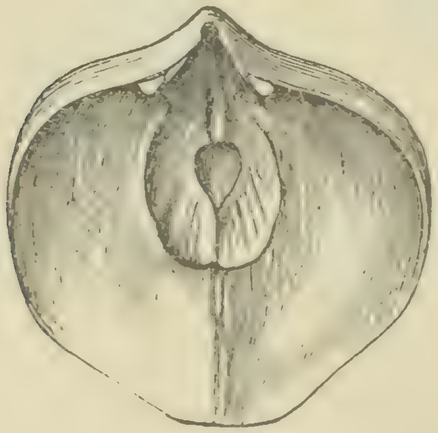


FIG. 83.—Interior of the pedicle-valve of *Athyris spiriferoides*; showing adductor and diductor scars

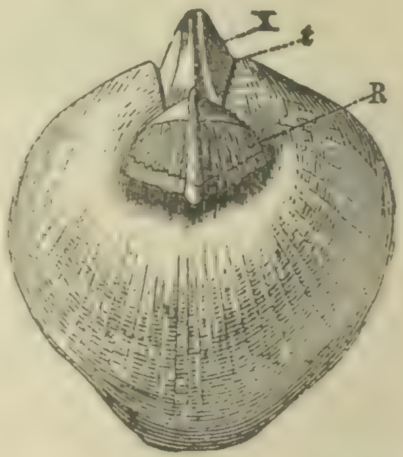


FIG. 84.—Internal cast of the pedicle-valve of *Meristella nasuta; X*, filling of rostral cavity; *t*, position of teeth.

Pallial Sinuses and Genital Markings.

Traces of these features are frequently retained on the shell with more or less distinctness. The *pallial sinuses* are usually two convergent (Lingula, Obolus) or divergent (Strophomena, Stropheodonta, etc.) trunks, from the outer margins of which emanates a series of secondary ramifying branches. Among the inarticulates there may also be branches along the inner margin of these sinuses. In Strophomena, Stropheodonta, etc., the inner margin of the main trunks bounds the genital area, which

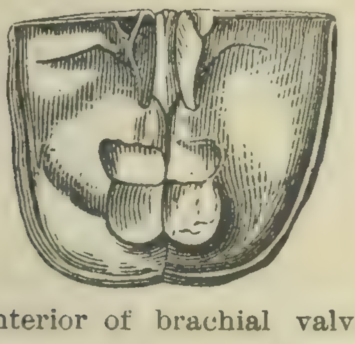


Fig. 85.— Interior of brachial valve of *Ambocoelia umbonata;* showing the four adductor scars.

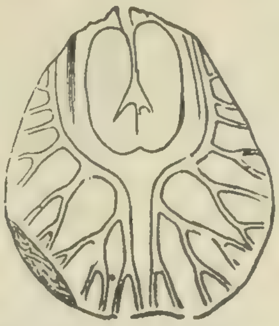


Fig. 86.— *Eatonia peculiaris.* The pallial sinuses on an internal cast of the pedicle-valve.

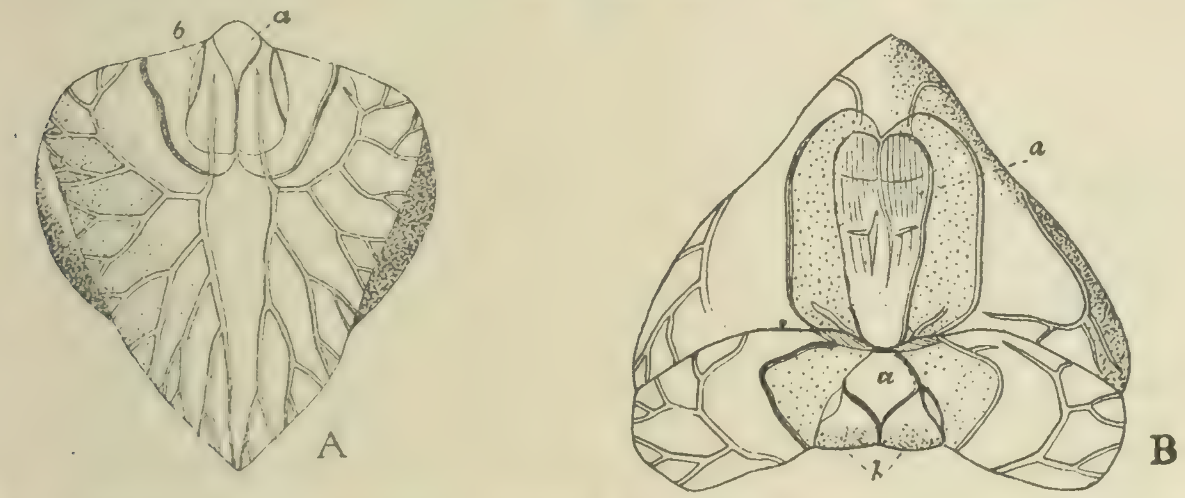


Fig. 87.— *Rhynchonella acuminata,* showing the pallial sinuses on an internal cast. A pedicle-valve; B, umbonal view; *a*, adductor scars; *b*, diductors. (Woodward.)

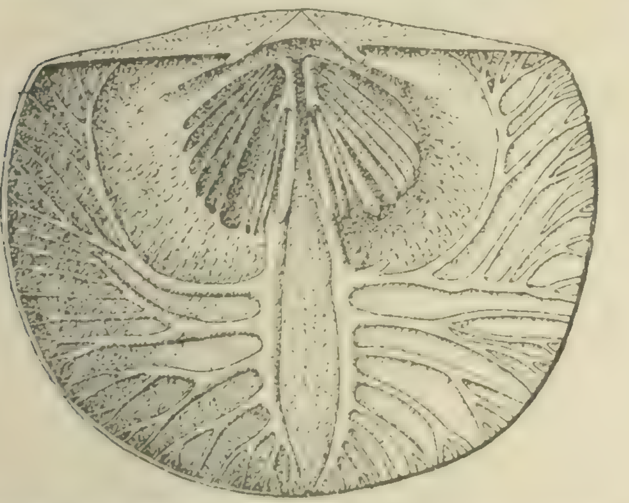


Fig. 88.— *Rafinesquina expansa.* Interior of pedicle-valve, showing pallial sinuses. (Davidson.)

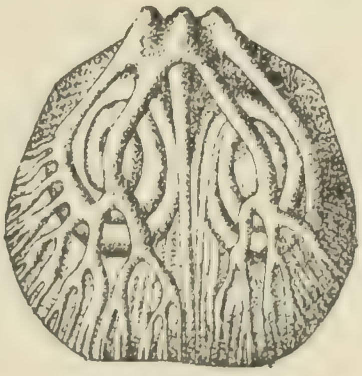


Fig. 89.— *Koninckina Leonhardi;* interior of brachial valve, showing pallial sinuses crossing the impressions of the spiral arms. (Woodward.)

usually has a pitted surface. In Schizophoria there are four or more subparallel longitudinal main pallial sinuses which subdivide toward their distal extremities. (Plate 11, figs. 21–23.)

Further reference will be made to the structure of the sinuses and genital organs.

Structure of the Test.

The valves of the Brachiopoda are composed of successive laminæ of heterogeneous structure. These may be wholly calcareous, and not more than two or three in number, or alternately calcareous and corneous, and not restricted to any numerical limit. Shells largely corneous or chitinous in their composition are restricted to the inarticulate division, but the inarticulates do not all possess corneous shells. In the living Lingula there is an alternation of corneous and calcareous layers varying in thickness, the former being compact and imperforate, the latter fibrous or prismatic and crossed by a great number of minute tubules. In fossils of this group the calcareous matter is frequently more or less removed, so that shells in this condition may appear to be essentially corneous in their composition. In the group of fossil linguloids, beginning with Lingula, passing through Lingulops and Lingulasma to Trimerella and its allies, there is a regular increase in the relative amount of calcareous matter in the shell, so that the Trimerellas, which are large and ponderous shells, seem to have wholly lost their corneous matter. In Crania also, the shell is essentially calcareous and the successive layers are punctured by tubules or vertical canals, which are largest at their openings on the interior of the valves, and narrow toward the outer surface. These never pierce the thin outer or epidermal layer of the shell.

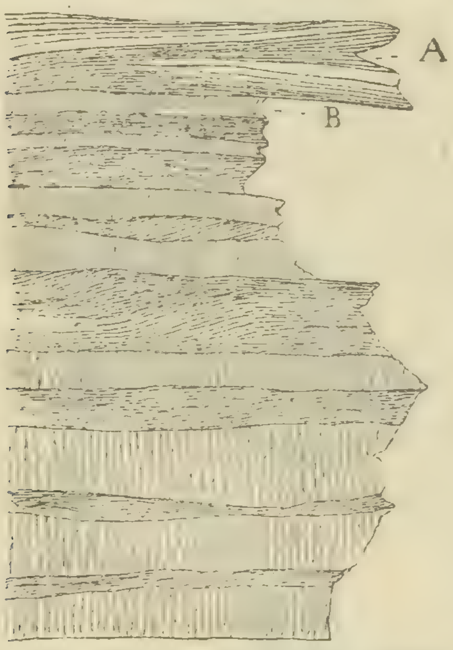


Fig. 90 — Magnified section of the thickest portion of the shell of *Lingula anatina*. *a*. corneous layers; *b*, mineral layers with vertical canals. (Gratiolet.)

Among the articulate genera, under favorable preservation, there may be distinguished three distinct calcareous shell layers; an inner prismatic or fibrous layer, which constitutes the greater portion of the shell; above this is a thin lamellar layer, and the outer surface of the shell is covered by a tenuous epidermal film or *periostracum.* When the shell is punctate, as is frequently the case (the orthoids, CYRTINA, SPIRIFERINA. the productoids, terebratuloids) the tubules open on the inner surface in narrow apertures, whence they widen upwards, abruptly expanding in the lamellar layer, at whose upper margin they terminate. They do not pierce the *periostracum*, and it has not been demonstrated that any brachiopod shell is completely traversed by them. Certain species of ORTHIS (RHIPIDOMELLA) have been shown by YOUNG to possess epithelial punctures which were probably the points of insertion of short spinules; these coexist with fine tubules which perforate the inner layers. The coarser spines occurring in such genera as SIPHONOTRETA and PRODUCTUS are hollow, and may sometimes penetrate the entire substance of the shell. The perforations vary greatly in size and number. In the terebratuloids

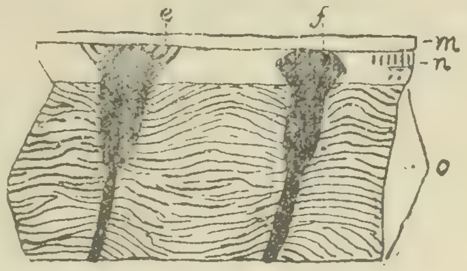


FIG. 91.—Shell structure of a punctate articulate branchiopod; *o*, prismatic layer; *m*, outer, impunctate layer; *n*, intermediate, laminar layer; *f*, broad extremity of perforation; *e*, radiating grooves about extremity.—(KING.)

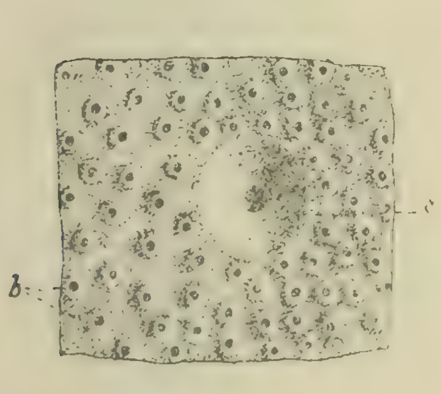


FIG. 92.—Inner surface of a valve of *Productus semireticulatus*, showing the opening of a spine (*s*) and the elevated terminations of the punctæ (*b*). (DAVIDSON.)

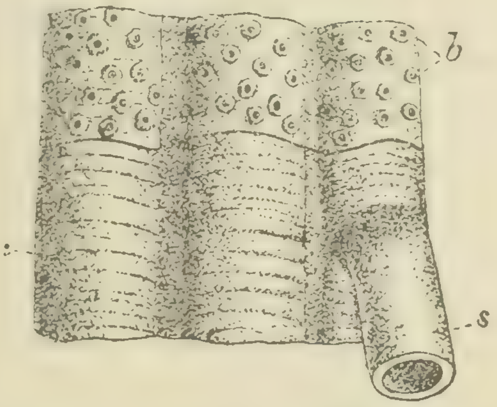


FIG. 93.—Portion of outer surface of *Productus longispinus*. *s*, spine; *c*, imperforate outer layer; *b*, punctæ of inner layer. (DAVIDSON.)

they are frequently visible to the unaided eye; in SYRINGOTHYRIS they are often difficult of discernment, and among fossils generally have probably been to some degree obscured by the process of fossilization. In smooth shells they are usually equally disseminated, but in plicated species they are arranged in rows on the plications or in the furrows. They may traverse the shell vertically, but their tendency is usually obliquely forward in the direction of shell-growth, and in some instances (*Tropidoleptus carinatus*) they converge toward the plications. Such variations in arrangement may leave certain portions of the shell impunctate while other portions are richly supplied with tubules.

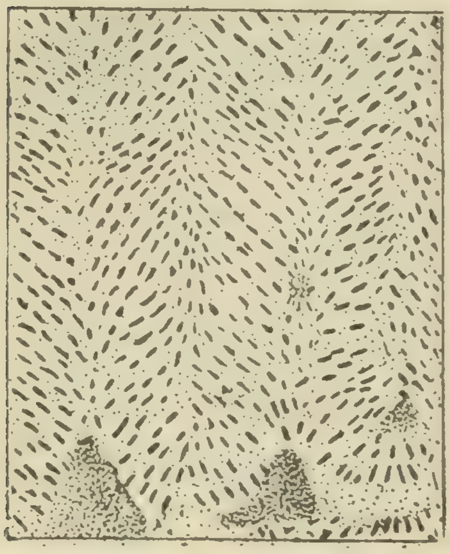


FIG. 94.—An enlargement of the shell structure in *Tropidoleptus;* showing the convergent tubules.

The full taxonomic significance of these test-perforations and their function, is not as yet understood. In certain groups of shells some of the members may be punctate, others impunctate. Thus among the orthids we find that the earlier and typical members (*O. callactis*, etc.), are completely impunctate; so also are PLATYSTROPHIA, HEBERTELLA and DINORTHIS; while the greater number of species belonging to the group, especially its later (Upper Silurian, Devonian and Carboniferous) members, are richly punctate. The shell of SPIRIFER, again, is normally impunctate, while the closely related genera CYRTINA, SPIRIFERINA and SYRINGOTHYRIS are punctate, and even a few species which must still be referred to the genus SPIRIFER have a sparsely punctated shell (*S. plenus*). RHYNCHONELLA and its recent and fossil allies are impunctate, except RHYNCHORA and RHYCHOPORA, which are simply rhynchonellids with punctate shell.

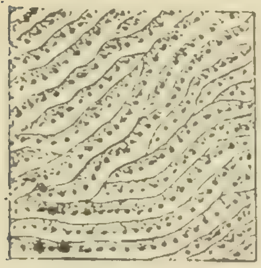


FIG. 95.—An enlargement of an exfoliated surface of *Spirifer plenus;* showing the shell punctations.

There are certain conditions which appear to have induced the deposition of impunctate shell-matter even in species uniformly perforated. JOUBIN has shown that the deposits about the edges and base of the muscular bundles is without perforations. The same is true of all adventitious deposits in punctate shells; senile enlargements of the teeth and cardinal process, the callosities in the delthyrium, as in SPIRIFER, and the syrinx in SYRINGOTHYRIS. Whether the teeth and other articulating apophyses are impunctate in their earlier condition, has not been determined. The calcareous secretions in the brachia (spirals, loops, etc.,) are also impunctate.

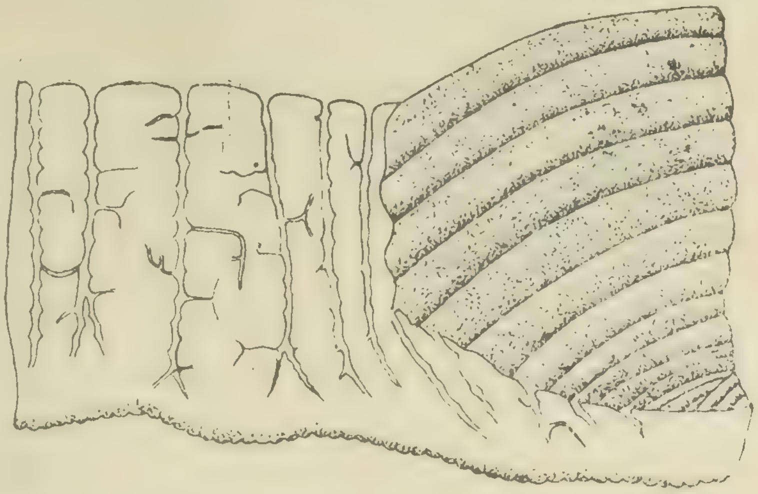


FIG. 96.—Vertical section of an attached valve of CRANIA, showing the normally perforate shell, and the imperforate deposit beneath the muscular scar (JOUBIN).

As to the function of the punctæ, it is quite generally believed that they are connected with the respiration of the animal. In recent punctate species the tubules are filled by diverticula from the mantle, which are readily seen by dissolving the shell of a terebratuloid in dilute acid. The fact, however, that they are not exposed to the water at their extremities may interfere with this interpretation, unless an increased exposure be effected by the access of water from within the body chamber. It has been observed by MORSE that the punctæ in TEREBRATULINA appear only after the shell has passed its earliest growth-stages.

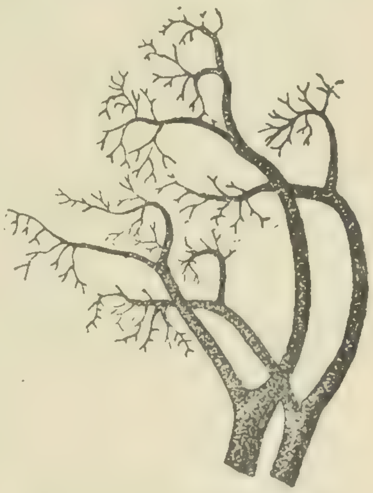


FIG. 97.—Extremities of the shell perforations in CRANIA.—(JOUBIN).

THE ANIMAL.

General Characters.

Upon opening the valves of a living brachiopod, the body, or that part of it which contains the essential organs, is found to be restricted to the posterior part of the internal cavity, while the anterior one-half or two-thirds of this space is filled by the coiled arms from which the name of the class is derived. The degree to which the valves can be voluntarily opened by the animal is very restricted, only sufficient to freely admit water currents to the brachia (TEREBRATULINIA, MAGELLANIA, etc.), or to extend the brachia when they are protrusible, as in HEMITHYRIS, etc. In *Lacazella mediterranea* the brachial valve in opening may traverse an arc of 90°, but no other species is known to possess this capacity. The *viscera* are separated from the cavity of the brachia by a vertical membranous wall, which is an extension of the *pallium* or *mantle*. The *shell-cavity* is, therefore, divisible into a posterior or *visceral cavity*, and an anterior or *brachial cavity*.

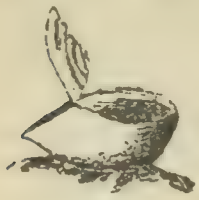


FIG. 98.—*Lacazella mediterranea*, with the valves open as in life. (LACAZE-DUTHIERS.)

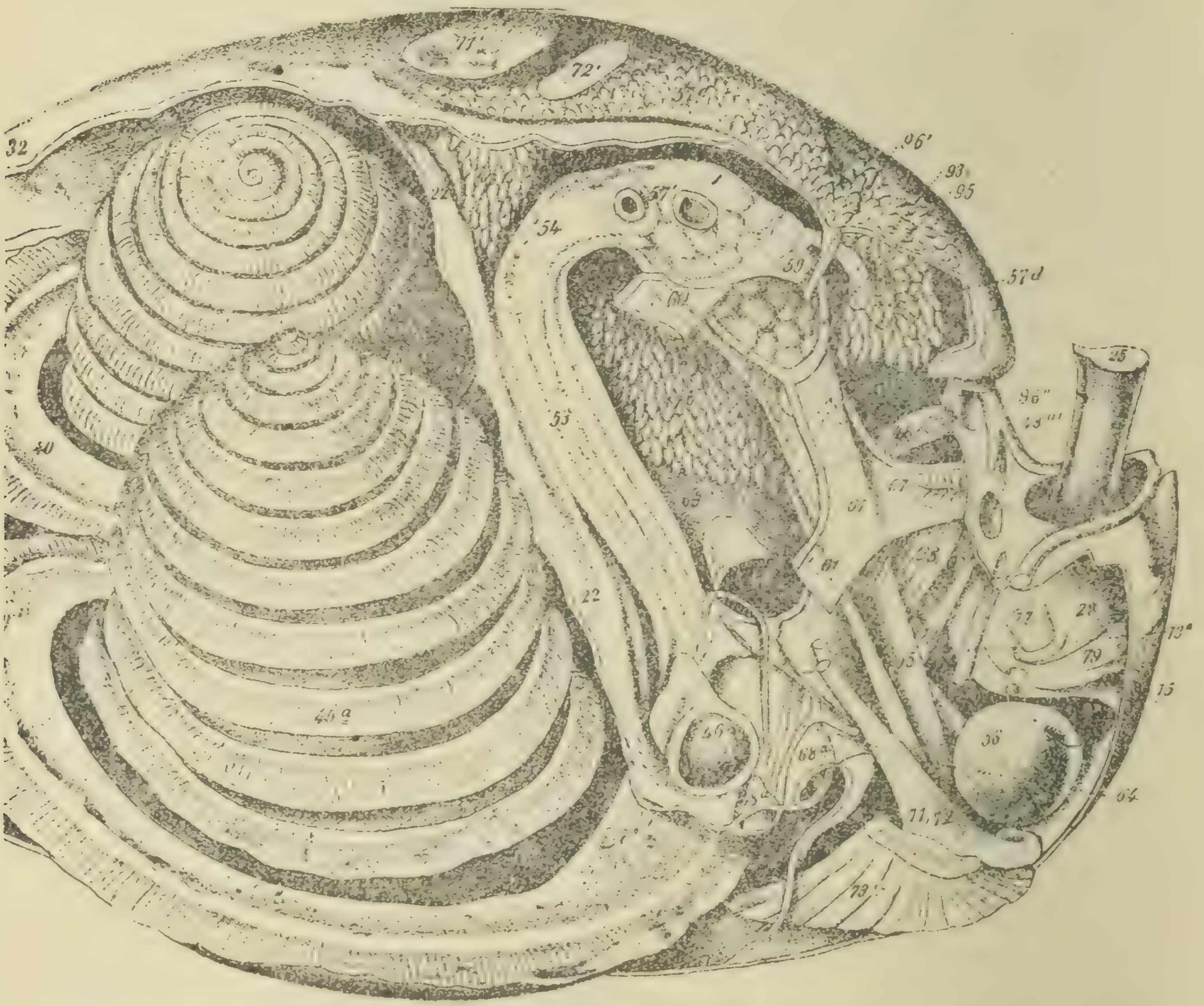


FIG. 99.—*Rhynchonella (Hemithyris) psittacea.*

The valves and a portion of the mantle removed, showing the vertical wall (22) dividing the body cavity into a posterior or visceral, and an anterior or brachial chamber. The notation of the other parts is as follows:

25, pedicle.
28, capsule of pedicle.
32, upper mantle lobe.
33, lower mantle lobe.
40, 40a, brachia.
46, 46a, brachial canal.
48, 48a, crural canal.
48a' aperture of same.
53, œsophagus.
54, stomach.
55, intestine.
56, blind extremity of intestine.
57, b, c, d, liver.
57', hepatic canals.
59, 60. gastroparietal band.
61, ilioparietal band.
63', 63" mesentery.
64, genital organs.
67, ventral funnel of oviduct.
68, tube of same.
71, 72, 71', 72' anterior and posterior adductors.
73, 73a, diductors.
75, 77, accessory diductors.
79, pedicle-muscle.
93, heart.
95, aorta
96, pallial artery.
96' 96" dorsal and ventral branches of same.

(BRONN after HANCOCK).

The Mantle.

This is a thin transparent membrane, appearing in the embryonic condition of the animal, as two distinct lobes. It is, primarily, the shell-secreting gland of the animal, and in all periods of growth it lines the entire inner surface of the shell.

In Crania, it is composed of three layers, a middle one, of compact, non-celluliferous tissue or cartilage, on each surface of which is a single layer of cells. From that which lies against the surface of the shell arise the cæca or blind tubes which enter the perforations of the test. At various points the mantle, or certain of its layers, folds upon itself, inclosing cavities or pallial sinuses which contain the circulating fluids and often portions of the genital organs. These sinuses frequently modify the interior

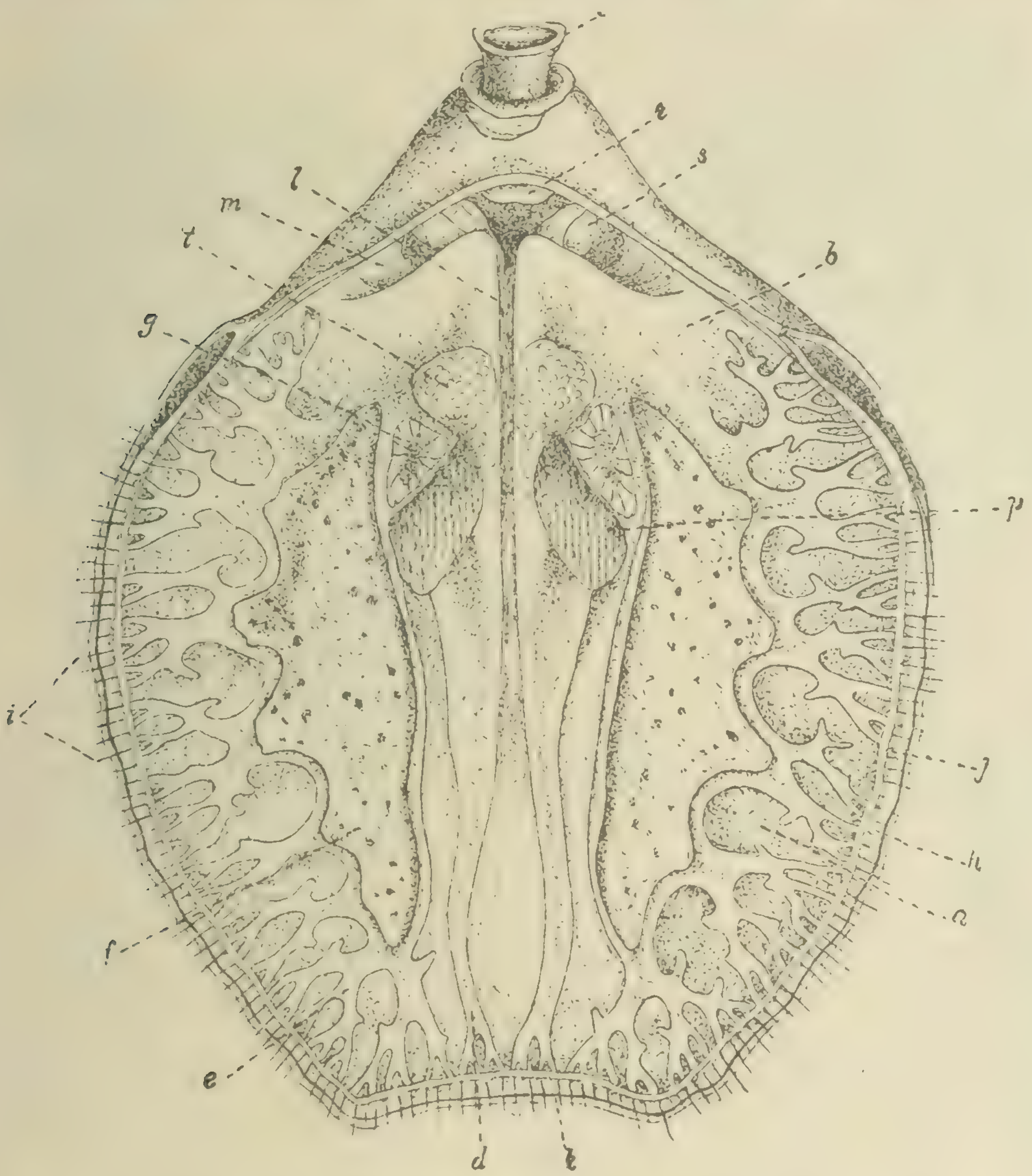


Fig. 100.—The animal of *Magellania australis*, viewed from the dorsal side.

a, mantle; *b*, body; *c*, pedicle; *d*, trunks of pallial sinuses; *e*, branches of pallial sinuses; *f*, genital organs; *g*, posterior adductor muscles; *h*, marginal fold of mantle; *i*, setæ; *j*, circumpallial vessel; *k*, edge of mantle; *l*, median fissure corresponding to septum of valve; *m*, depression caused by hinge-plate; *p*, anterior adductor muscles; *r*, diductors; *s*, accessory diductors; *t*, liver.—(Hancock.)

of the valves so strongly that their traces are visible when the shell is petrified, and may be seen not only over the brachial region but also where the mantle is extended posteriorly between the margins of the visceral area and the edges of the valves the *parietal region*).

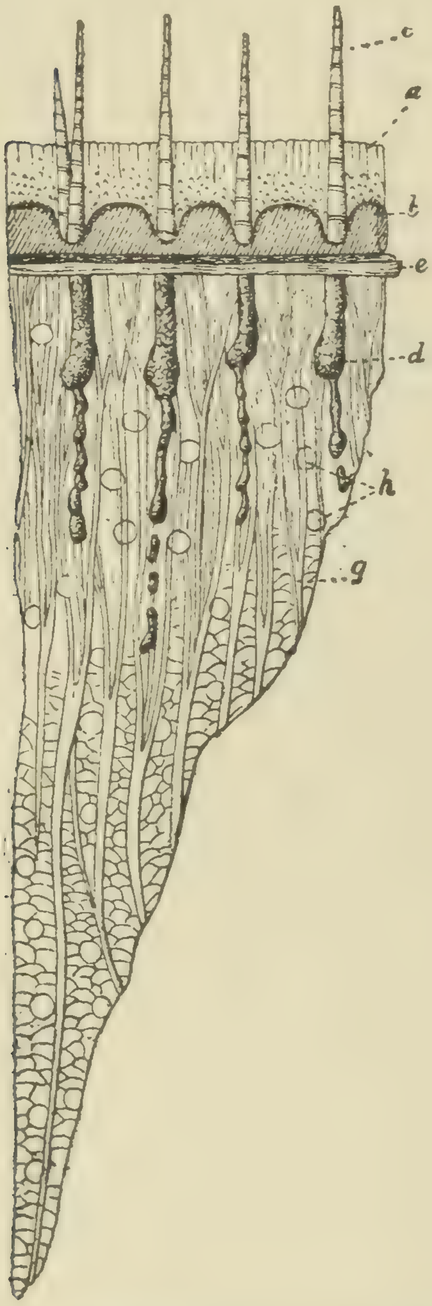


FIG. 101.—Marginal portion of the mantle of *Magellania australis*.
a, margin; *b*, marginal fold; *c*, setæ; *d*, follicles of setæ; *e*, circumpallial muscular belt; *g*, pallial muscles; *h*, bases of pallial cæca.—(HANCOCK).

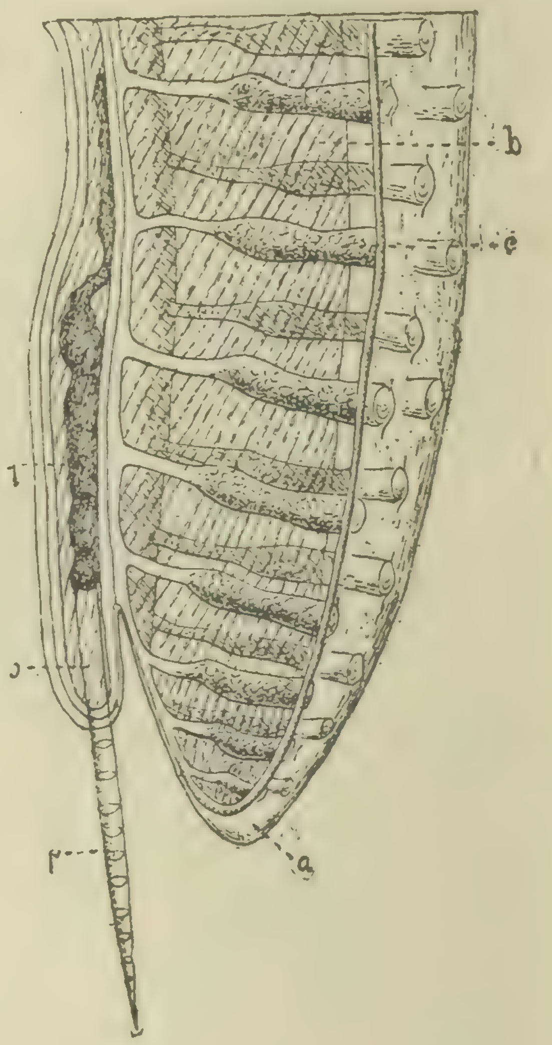


FIG. 102.—Vertical section of shell and mantle of *Magellania australis*.
a, margin of valve; *b*, shell showing prismatic structure; *c*, pallial cæca penetrating shell; *o*, marginal fold of mantle; *p*, one of the setæ; *q*, follicle of the same; *t*, extreme pallial margin.—(HANCOCK.)

In all the larger cavities of the body, including not only the greater sinuses of the mantle but also the perivisceral cavity and the cavernous brachia and cirri, are found calcareous spicules of various shapes which, in some genera, especially THE-

CIDIUM and its allies, unite to form an irregular mass or net-work. It is to a certain degree true that the spicules in a given species or genus have the same general aspect; and while they abound in most genera, there are a few (MAGELLANIA, TEREBRATELLA, LINGULA) in which they are absent, or have not been observed. The mantle extends to the edges of the valves and its outer margins are thickened, and set with stout chitinous setæ, each of which is lodged in a follicle or sac. The form and exterior of these setæ varies somewhat in different generic groups; in

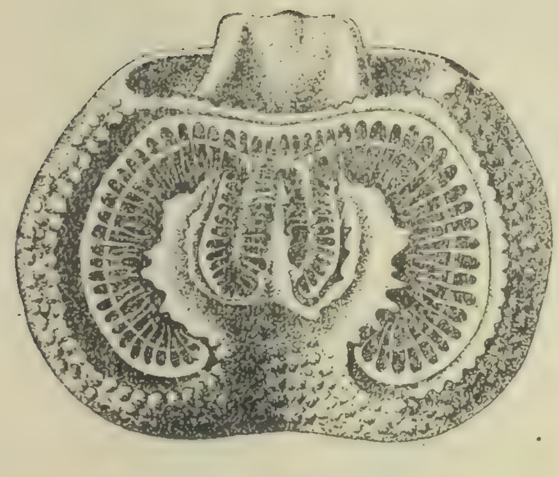


FIG. 103.—*Thecidium mediterraneum.* Interior of the brachial valve; showing the loose spiculization of the shell-substance about the brachia.—(WOODWARD.)

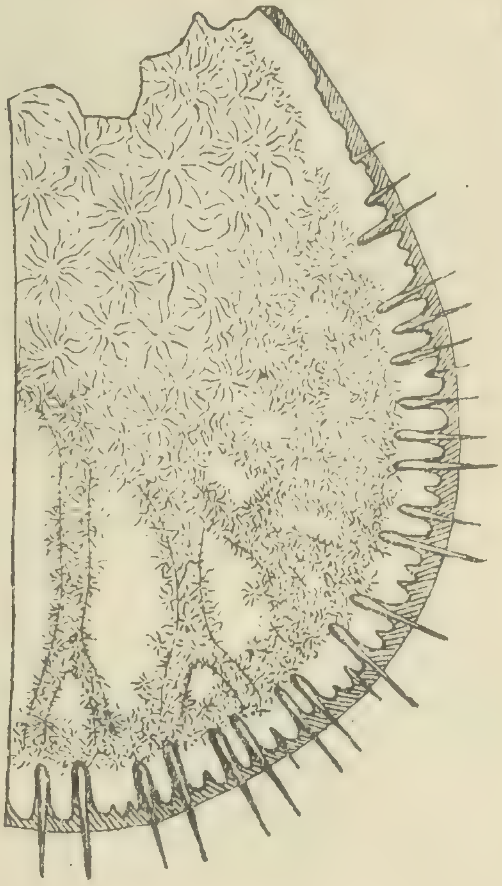


FIG. 104.—Portion of the mantle of *Terebratulina caput-serpentis,* showing spicules.—(HANCOCK.)

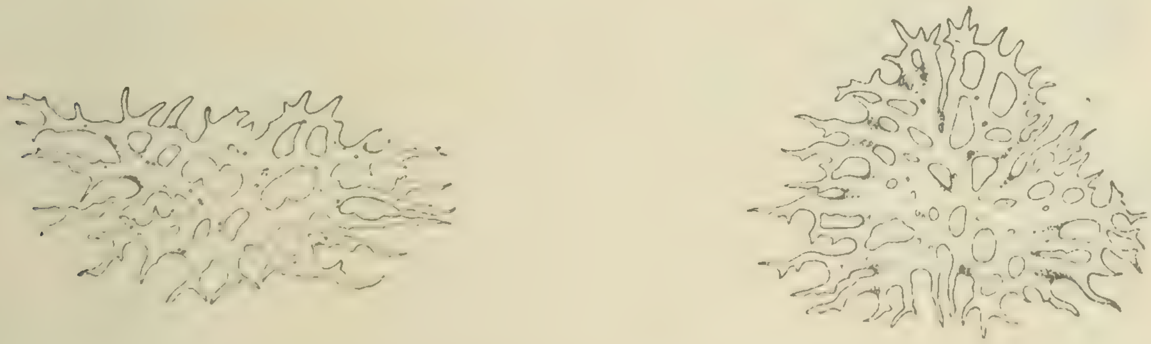


FIG. 105.—Spicules of *Terebratulina*, greatly enlarged.—(HANCOCK.)

Discinisca their edges are barbed. The function of the setæ seems to have been mainly protective, but in Glottidia, where they are of considerable length, they are said, by Morse, to be an important aid to locomotion.

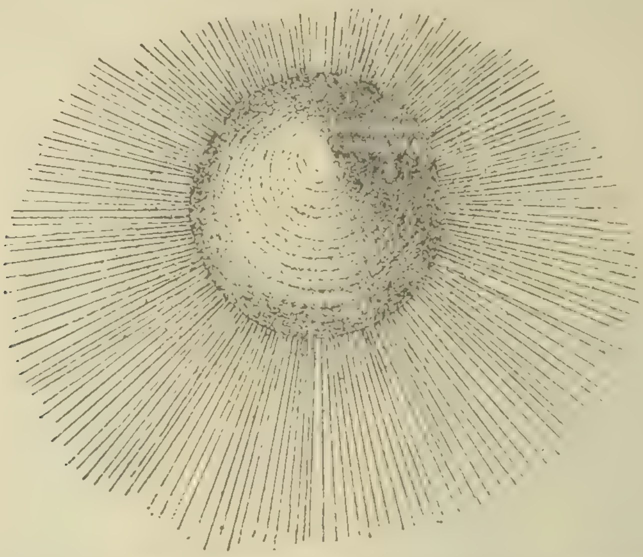


Fig. 106.—*Discinisca atlantica;* showing barbed setæ.—(Davidson.)

The Pedicle.

This is the *organ of attachment* to extraneous bodies. In Magellania and the articulate brachiopods generally, it is a short, stout cylinder, whose inner extremity terminates in, and is attached to the umbonal surface of the pedicle-valve, its outer extremity being protruded through the delthyrium or the foramen in species or stages of growth, where the latter exists. Under other circumstances it may be protruded between the valves, or may be altogether functionless and atrophied at maturity, as is true of the greater part of early fossil species. This organ is a compact, inelastic cylinder of dense muscular tissue. The exposed portion is covered by a thick corneous sheath, and the inner extremity is received into a muscular capsule by means of which attachment to the pedicle-valve is effected. Within the corneous covering is a mass of muscular tissue.

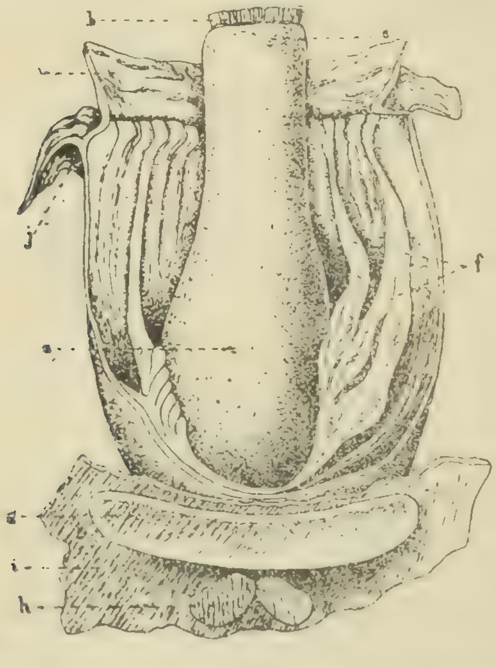


Fig. 107.—Pedicle of *Magellania australis* with capsule laid open. *a*, pedicle; *b*, muscular mass of same; *c*, horny sheath; *e*, margin of orifice leading into capsule; *f*, plications on inner surface of capsule; *g*, pedicle-muscle; *h*, assessory diductors; *i*, wall of perivisceral chamber (pedicle-valve); *j*, same (brachial valve).—(Hancock).

In Lingula the pedicle is a very flexible, highly muscular body, often enormously developed in length. At its point of emergence from the valves, it is exceedingly thick, abruptly contracting from this point inward. It is composed of two layers; an outer, thin corneous one, and an inner muscular one. The organ is traversed for its entire length by a central canal which is connected with the chamber inclosing the viscera (*perivisceral cavity*). The capsule, so highly developed in the terebratuloids is here rudimentary, while the pedicle-muscle is well developed. In Glottidia the pedicle has been shown by Morse to be annulated, supplied with mural pores, and the central canal to be filled by a circulating sanguineous fluid. It has already been observed that in *Glottidia Audebardi* the pedicle forms for itself a covering of agglutinated sand grains, etc., being otherwise unattached, and also possesses the power of contracting itself violently in all directions. All of these characters are very suggestive of relations to the Annelids, as has been forcibly argued by the author quoted.

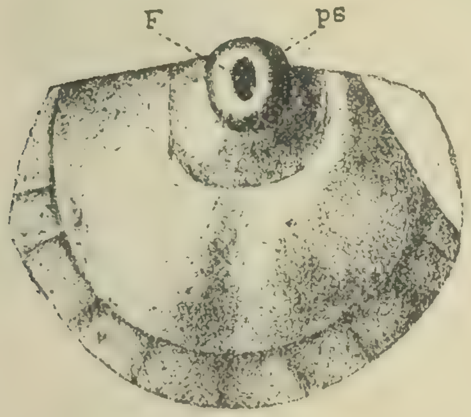


Fig 108.—*Leptœna rhomboidalis.* A very young shell, x10. F, foramen; *ps*, pedicle-sheath. (Beecher and Clarke.) For the mature shell see plate 13, figs 2, 3.

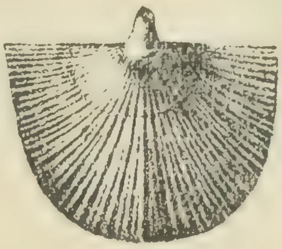


Fig. 109.—*Rafinesquina Ulrichi* An adult shell with the pedicle-sheath highly developed.

Muscular System.

The Brachiopoda which are articulated by teeth and sockets can open and close their valves only in a vertical plane, and even in this direction the capability of motion is very limited. They also possess, to a limited degree, the power of protruding and retracting the pedicle. We therefore find in the articulate brachiopods *three* sets of muscles, namely: Those which by contraction open the valves (*diductors*), those which by contraction close the valves (*adductors*), and those which by contraction withdraw the pedicle (*pedicle-muscles*). The arrangement of these is uniformly simple, and the plan is not essentially varied throughout the articulate group. As to the valvular muscles, it is a noteworthy fact that the same muscular action (contraction) produces directly opposite results, on account of the difference in the position of insertion of the muscles of the brachial valve.

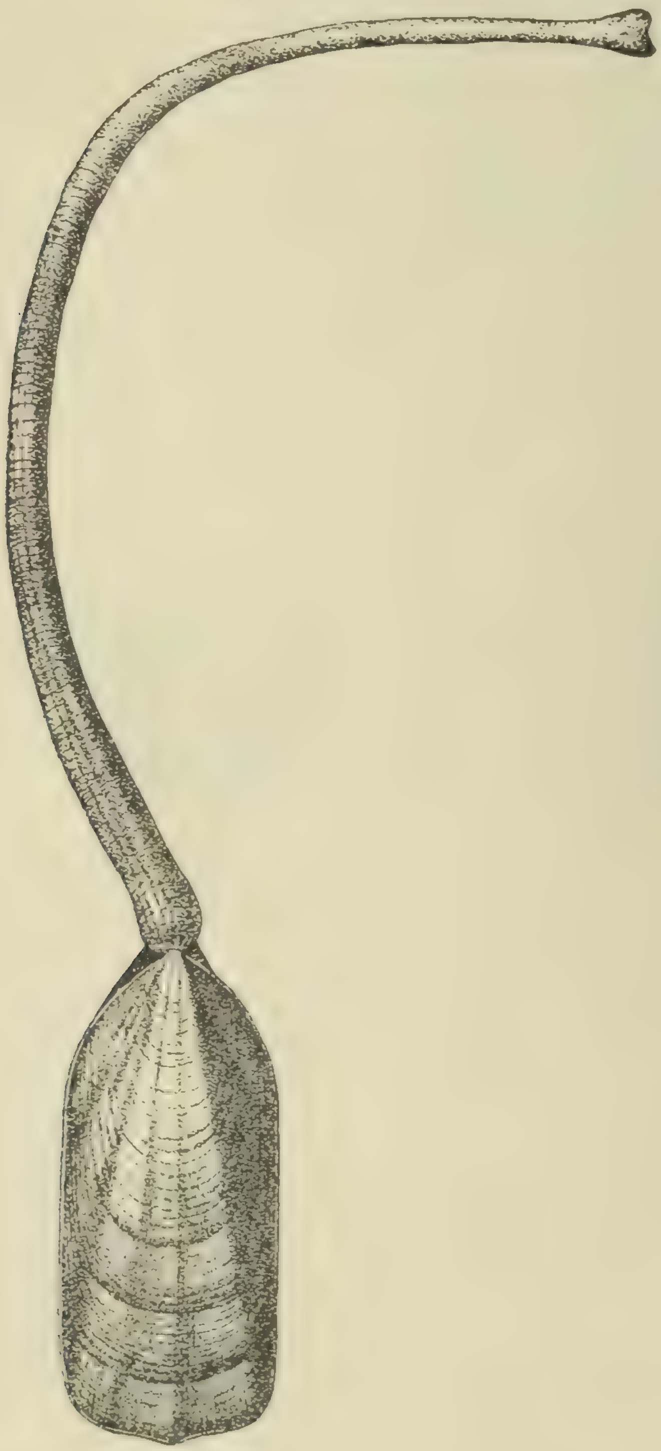


Fig. 110.—*Lingula Murphiana.* (Davidson.)

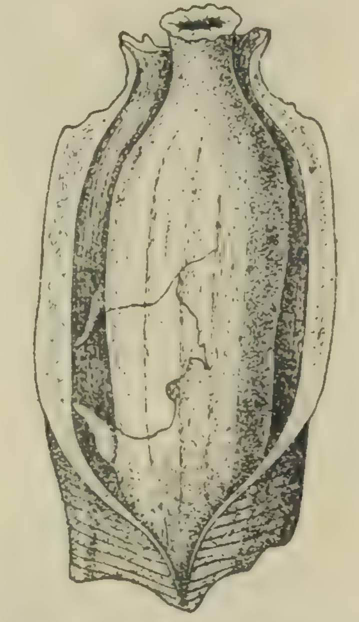


Fig. 111.— Extremity o pedicle of *Lingula anatina*, with horny sheath laid open, exposing the muscular cylinder and its membraneous coat. (Hancock.)

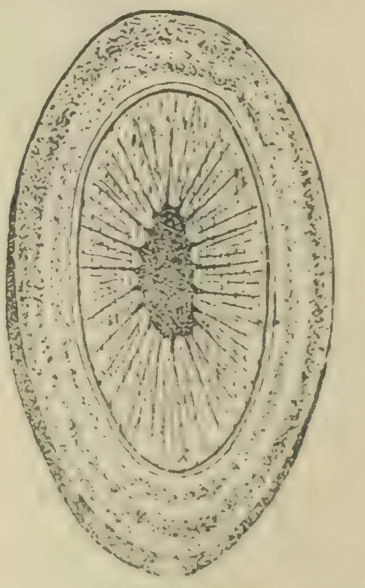


Fig. 112.—Transverse section of pedicle of *Lingula anatina*. (Hancock.)

Thus, in the pedicle-valve of any living brachiopod like Terebratulina or Magellania, the principal *diductor* or opening muscles take their origin at the anterior edge of the visceral area and on either side of the axial line. They rapidly diminish in size in crossing the interior cavity, and their small extremities are inserted on the anterior portion of the cardinal process of the brachial valve. These muscles are, almost without exception, the largest, and leave the deepest scars upon the shell of any in the animal. The reason of this is that the muscles by contraction act upon a very short lever-arm (cardinal process) through which they must overcome the resistance expressed in the weight of the entire body of the brachial valve attached by its posterior

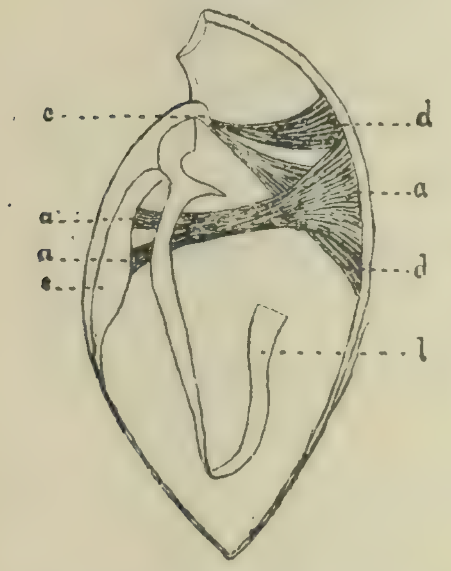


Fig. 113—Muscular system of *Magellania*. *a*, adductors; *d*, *d*, diductors; *c*, cardinal process; *s*, septum of brachial valve; *b*, brachial supports. (Davidson).

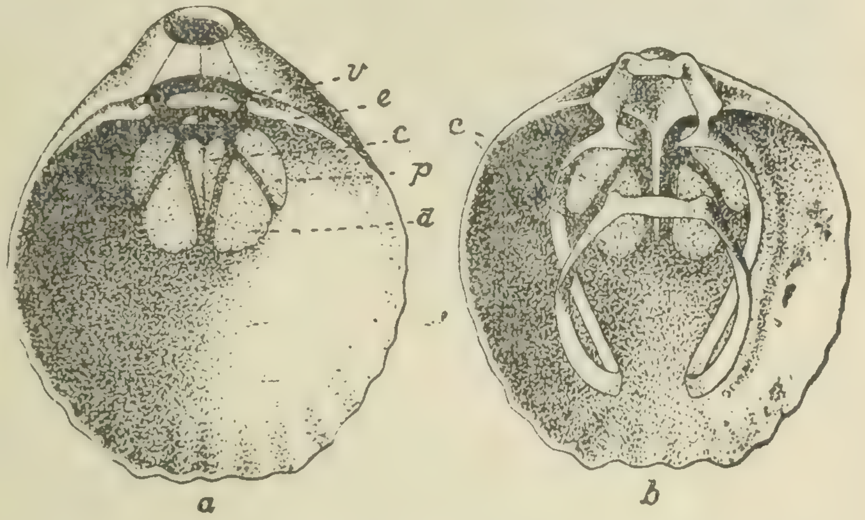


Fig. 114.—*Magellania flavescens*. *a*, pedicle-valve; *b*, brachial valve; *c*, adductor scars; *d*, diductors; *e*, accessory diductors; *p*, ventral pedicle-muscle; *v*, median pedicle-muscle. (Davidson.)

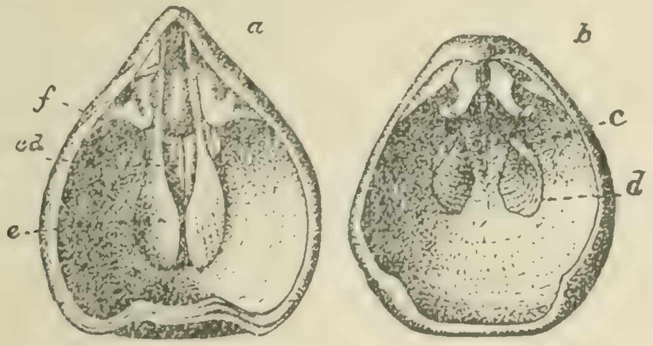


Fig. 115.—*Hemithyris psittacea*. *a*, pedicle-valve; *b*, brachial valve; *c*, posterior adductors; *d*, anterior adductors; *e*, diductors; *f*, pedicle-muscles. (Davidson.)

margin. In species where the cardinal process is feebly developed, as in the plicated Spirifers, these muscles were very powerful, as is evinced by the deeply excavated scars they have left; so, also, in Orthis (Rhipdomella) and Hipparionyx (Plates 12, 16) the scars may cover a great part of the inner surface of the valve, extending almost to the anterior margin; while in other species where the cardinal process was larger and the leverage more equable, these scars are much feebler and of less size (Triplecia, Streptorhynchus, Stringocephalus; Plates 17, 18). In the posterior part of the muscular region of the pedicle-valve are two much smaller muscular bands (*accessory diductors*, see figure 114) which are inserted on the cardinal process behind the principal diductors. The scars of this pair are very rarely seen among the fossils, and it is doubtful if they existed among the early genera, such as Orthis, Strophomena, Stropheodonta, etc., where the principal diductors attained such great size.

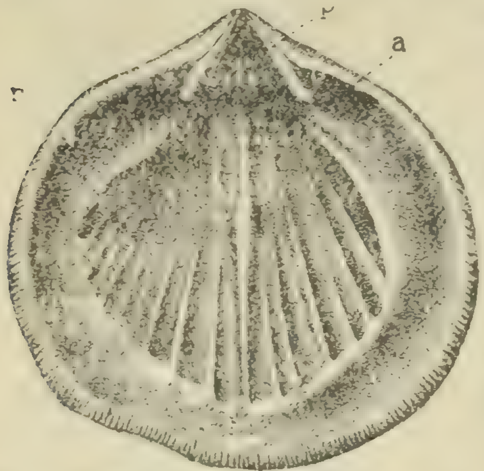


Fig 116.—*Orthis musculosa.* Interior of a pedicle-valve: *a*, adductors; *r*, diductors; *p*, pedicle-muscle.

The *adductor* or *closing muscles* have a double origin on the pedicle-valve, leaving two elongate scars on either side of the median line, and lying between the scars of the diductors. They traverse the interior cavity almost perpendicularly to the valves, each muscular band dividing, and their insertion on the brachial valve being therefore quadruple. Their divisions on that side of the animal are known as *anterior* and *posterior adductors.* The central position of these muscles gives them a great mechanical advantage in closing the valves and they are therefore less powerful than the diductors; among the fossils they are often obscurely defined. The size and definition of these scars will always be found in direct relation to the amount of work required of the muscles. Thus in Stropheodonta and Productus their insertion upon the brachial valve is so far back that they are at a disadvantage in moving this valve; and in both of these genera, the scars are usually strong. In

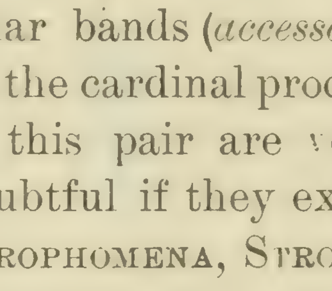


Fig. 117.—Interior of brachial value of *Orthis Vanuxemi.* *j*, cardinal process; *a*, *á*, anterior and posterior adductors.

Spirifer, on the other hand, where the mechanical advantage was greater, these impressions on the brachial valve are often scarcely discernible, and, as is often the case among the fossils, the quadruple division of the insertion on this valve is quite obscure.

Besides the valvular muscles, there are *two pairs* and a single *unpaired* muscle which are attached to the *pedicle*. One originates on the pedicle-valve at points just outside and behind the diductors; the other pair is attached to the brachial valve behind the posterior adductors, while the unpaired muscle lies at the base of the pedicle, attaching it closely to the pedicle-valve. Of all these muscles for the retraction of the pedicle, it is only the unpaired band that often leaves a discernible scar upon the valve, and in numerous fossil species where the pedicle early became atrophied, even this scar is covered by later depositions of testaceous matter. Among some of the inarticulate brachiopods the muscular system is quite as simple as in the articulates. In Crania there are *two pairs* of strong muscular bands, the one *median* and close together, the other *posterior* or *cardinal*, and further apart.

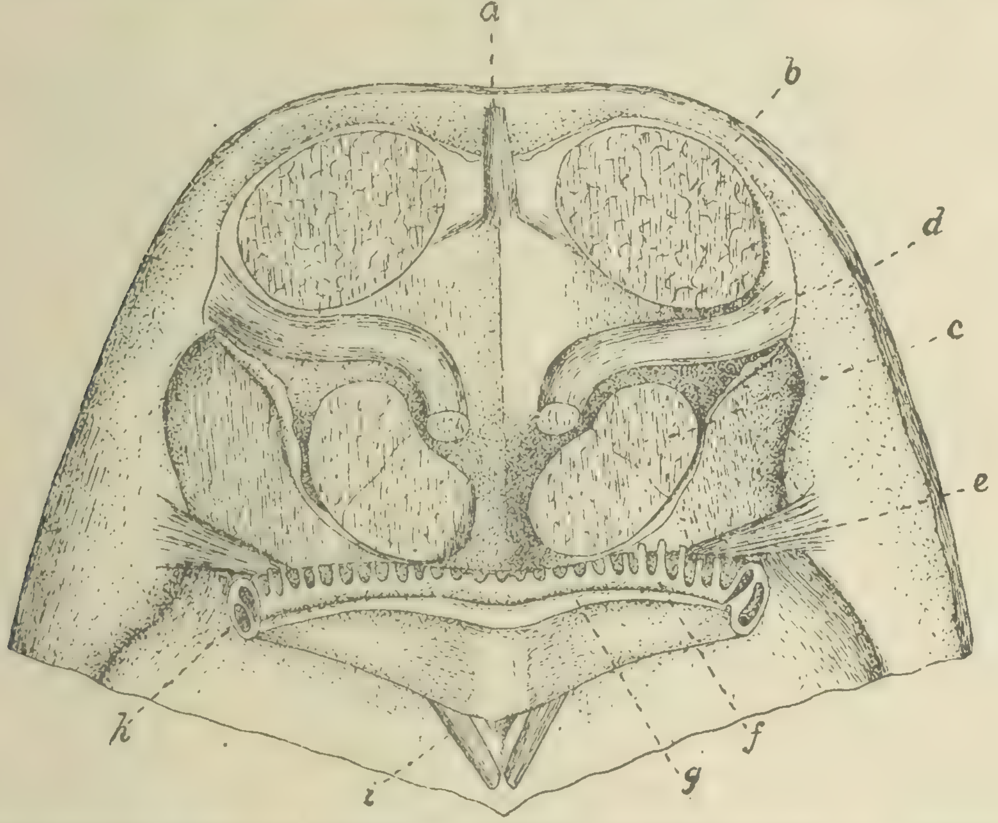


Fig. 118.—The muscular system of *Crania*. *a*, median unpaired muscle; *b*, posterior adductor; *c*, anterior adductor; *d*, protractor; *e*, brachial muscles; *f*, oral surface; *g*, brachial fold; *h*, arm; *i*,=*e*. (Joubin.)

The former (*anterior adductors*) close the valves, the latter (*posterior adductors*), by their contraction, *open* the valves to the very limited extent possible among these shells. In addition to these is a single small pair which is attached to both valves (*protractors* of the free valve), which effects a slight forward and backward movement of the upper valve. Two other small muscular pairs are attached to the brachia, and have their origin on one of the valves (*protractors* and *retractors* of the brachia). There is also a small unpaired muscle originating on the surface of the upper valve, close to the margin and in the median line; this is attached to the viscera, and according to Joubin, by its contraction the passages from the genital organs are opened.

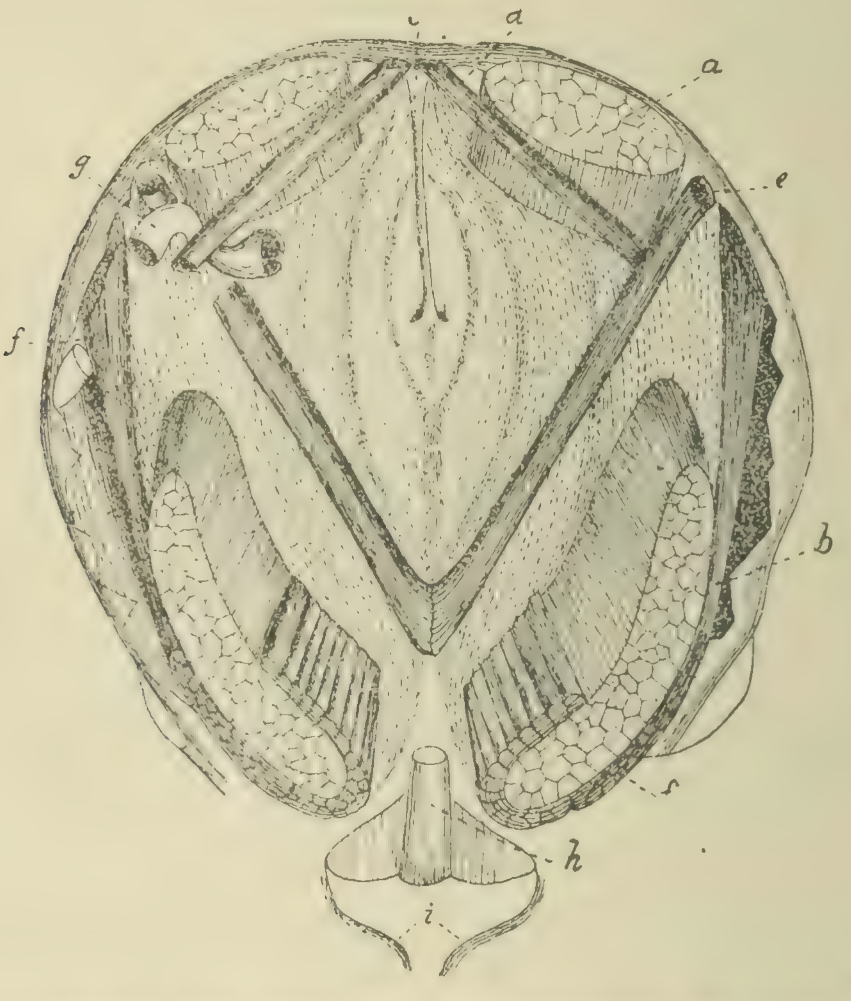


Fig. 119. — Muscular system of *Discinisca*, the muscles remaining attached to the pedicle-valve. *a*, posterior adductor; *b*, anterior adductor; *c*, median unpaired muscle; *d*, posterior protractor; *e*, anterior protractor; *f*, retractor; *g*, intestine; *h*, œsophagus; *i*, arms. (Joubin.)

In Discinisca the arrangement of the muscles is very similar, there being two pairs, instead of a single pair of *protractors*, which slide the upper or brachial valve outward over the edges of the attached valve, while a single pair of *retractors* draws the valve into place again. There is also here an unpaired median muscle which is probably an organ of retraction of the pedicle.

In Lingula and its allies the muscles are more numerous and their arrangement far more complicated than in other brachiopods. These animals possess the power of separating the valves in a manner unlike that of other members of the class; that is, of sliding them apart laterally or rotating them through a short arc about the longitudinal axis of the shell. The muscular area occupies a relatively large portion of the internal surface, the bands being arranged about the margins of the visceral area. In the umbonal region there is a central, undivided muscle, crossing the interior cavity vertically; this is the *umbonal* or *diductor* muscle, by its contraction opening the valves along their anterior margins.

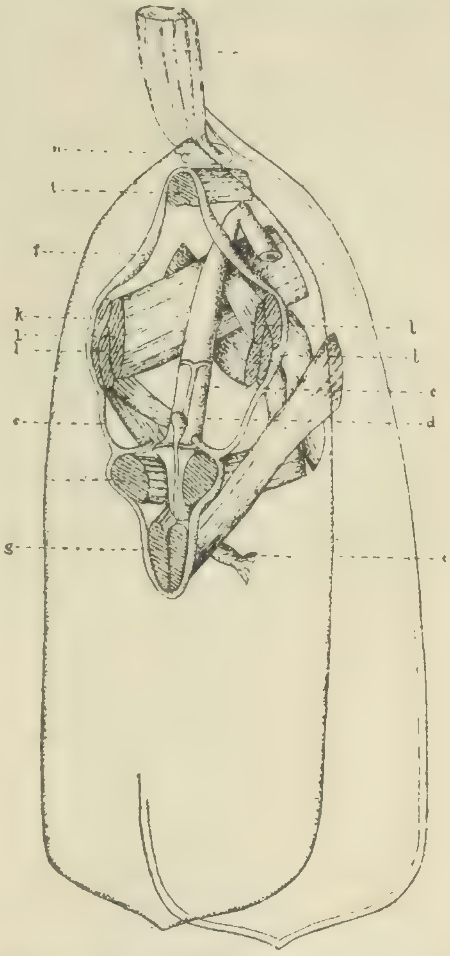


Fig. 120. — Muscular system of *Lingula anatina*: *c*, alimentary canal; *d*, dorsal vesicle; *e f*, walls of perivisceral cavity; *g*, retractors; *h*, adductors; *i*, umbonal; *j k*, protractors; *l*, rotators; *m*, pedicle; *n*, pedicle muscle.—(Hancock).

The *adductors* (or *centrals*) are a single pair situated near the anterior extremity of the area, and they also cross the shell cavity vertically. At the anterior extremity of the area in the pedicle valve originates a single pair of *protractors* (*middles*), each member of which extends backward and is inserted near the lateral margin of the brachial valve, while a second pair of *protractors* (*externals*) originates just behind the adductors of the pedicle-valve and is inserted behind the first pair. These muscles, by their combined action, or independently, draw the brachial valve forward. The *retractors* (or *anteriors*), or those which readjust the brachial valve, extend from the outer lateral margins of the area in the pedicle-valve to its anterior extremity in the brachial valve. Neither *protractors* nor *retractors* cross the perivisceral cavity. The *rotators* (*transmedian* or *sliding-muscles*) are three in number, two on one side and three on the other. These are situated posteriorly and cross the perivisceral cavity diagonally, the undivided muscle passing between the other two. The contraction of these, alternately rotates the brachial valve, first in one direction and then in the other. In Lingula, also, the *paries* or vertical extension of the mantle which incloses the viscera is highly muscular and leaves an impression on the valves. In ancient and fossil forms of Lingula it is evident that the arrangement was similar to that of living species, and though specimens have been rarely seen which show the muscular scars clearly, a few have been recorded which have retained the scars with great distinctness. In Obolus, Mickwitz finds that, while the general arrangement of the scars is similar to that of Lingula, the umbonal diductor is simple at its insertion in the brachial valve, and divides in crossing the cavity. This author also ascribes two distinct pairs of scars to the *rotators*, one to the *adductors* and another pair which may be either adductors or a third pair of rotators.

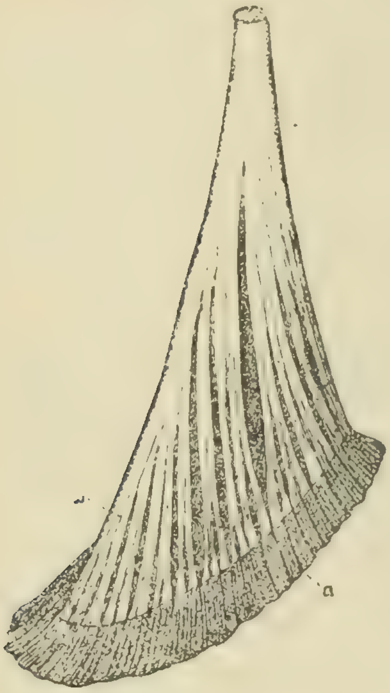


Fig. 121.— Extremity of adductor muscle of *Magellania australis*. *a*, contractile portion; *b*, tendinous portion. (Hancock.)

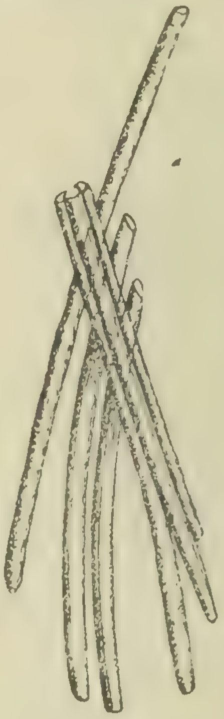


Fig. 122.— Non-striated muscular fibers of *Magellania australis*. (Hancock.)

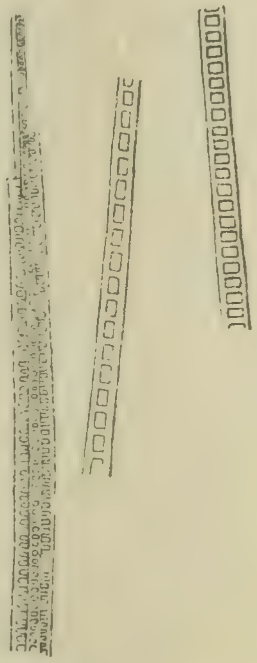


Fig. 123.— Striated posterior adductor or muscular fibers of of *Magellania australis*. (Hancock.)

There are some differences in the appearance of the muscular bands in the articulate and inarticulate brachiopods, those of the former tapering from origin to insertion, while in the latter they are of more equal thickness throughout. The muscular fibers are smooth, except in the posterior adductor bands where they striated.

Alimentary System.

The *mouth* is a simple orifice located centrally at the base of the fleshy brachia. In Megathyris the oval or buccal area is very broad, but in most brachiopods it is narrowed to a simple groove.

From this point the digestive tube extends backward as a simple bent canal, the flexure being toward the pedicle-valve. In inarticulate species it is much longer and more complicated than in MAGELLANIA, RHYNCHONELLA and the articulates generally. In LINGULA the digestive tube is very long and at the œsophagus is deflected ventrally; the stomach is short, rather more circular than elongate and the intestine makes three or four convolutions; in DISCINISCA and CRANIA there are some variations in the degree of convolution of this tube. In all of the living inarticulated species the intestine terminates in a well-defined *anus*, situated laterally in LINGULA, and in the median line in CRANIA.

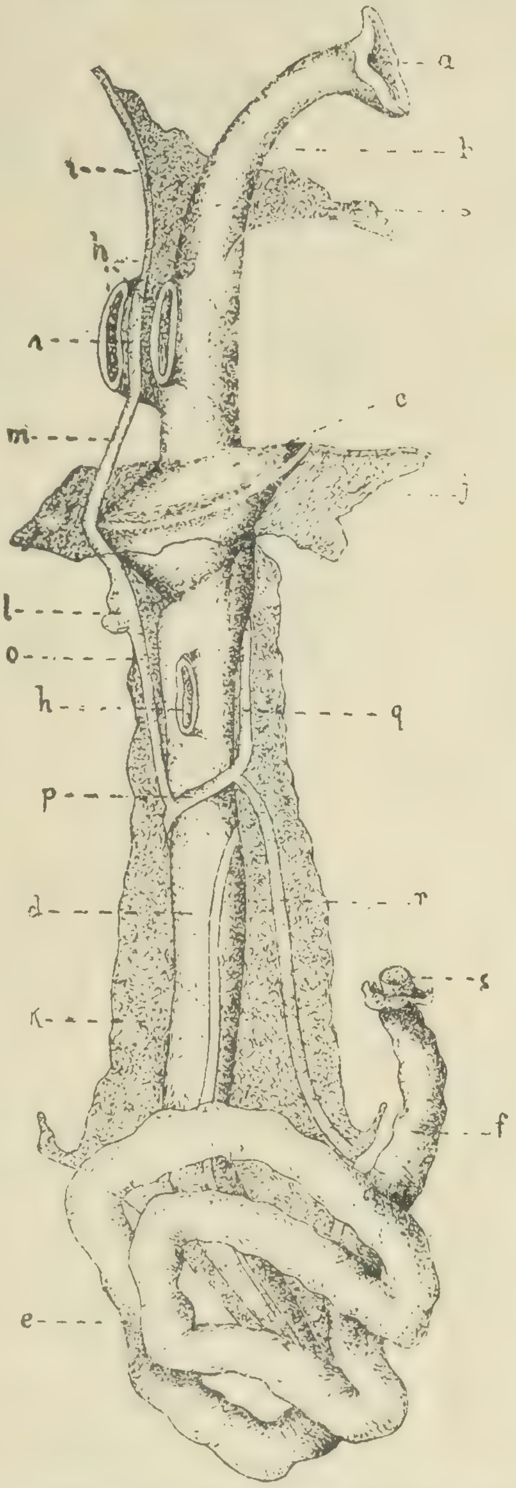


FIG. 124—Alimentary canal of *Lingula affinis*; *a*, mouth; *b*, œsophagus; *c*, stomach; *d*, intestine; *e*, convolutions of same; *f*, rectum; *g*, anus; *h*, hepatic ducts; *i*, dorsal mesentery; *j*, gastro-parietal bands; *k*, ilio-parietal bands; *l*, dorsal vescicle; *m*, *n*, *o*, *p*, *q*, *r*, blood-vessels; *s*, œsophageal membrane. (HANCOCK.)

In the articulates the alimentary canal is shorter and much simpler than in LINGULA, CRANIA, etc. In MAGELLANIA the *œsophagus* is short, and behind it the tube is slightly contracted, then expanding again into a moderately capacious *stomach*. The *intestine* is short, and toward its posterior extremity makes a single convolution near the hinge-plate of the brachial valve, and it is probable that, in some of the extinct genera, e. g. RENSSELÆRIA, CENTRONELLA, ATHYRIS, in which this plate is perforated by a central foramen, the intestine passed through it. The posterior end of the intestine is imperforate in all articulated brachiopods, and in MAGELLANIA it is a simple point attached to the *parietes* or lining membrane of the perivisceral cavity. The presence or absence of this terminal perforation is, therefore, of considerable importance in the classification of these animals, and has been made a basis of subdivision by KING, who proposed thereupon the ordinal divisions *Tretenterata* and

Clistenterata (=*Inarticulata* and *Articulata*, respectively). It is believed that in the Articulata the faeces are discharged through the mouth.

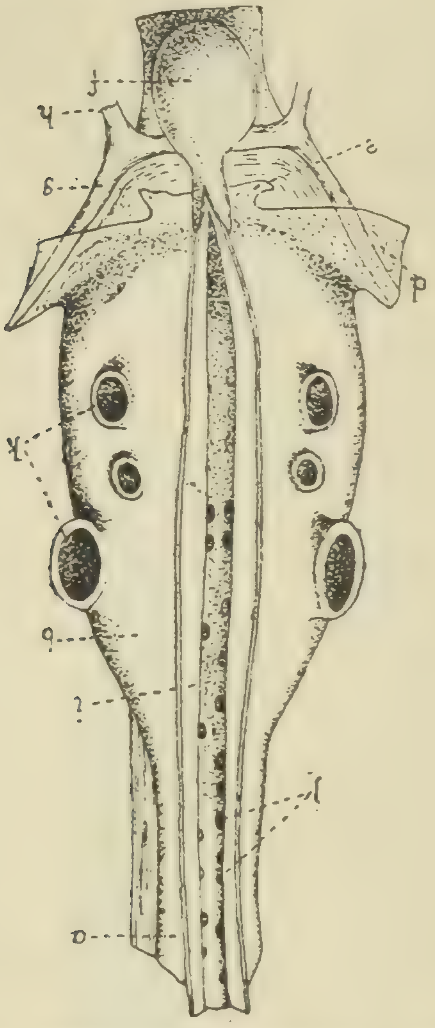


Fig. 125.—Stomach of *Magellania australis*. *a*, œsophagus; *b*, stomach; *d*, *e*, gastroparietal band; *f*, dorsal vescicle; *g*, *h*, blood-vessels; *i*, dorsal blood-vessel laid open, showing (*j*) orifices leading into gastral lacunes; *k*, hepatic ducts. (Hancock.)

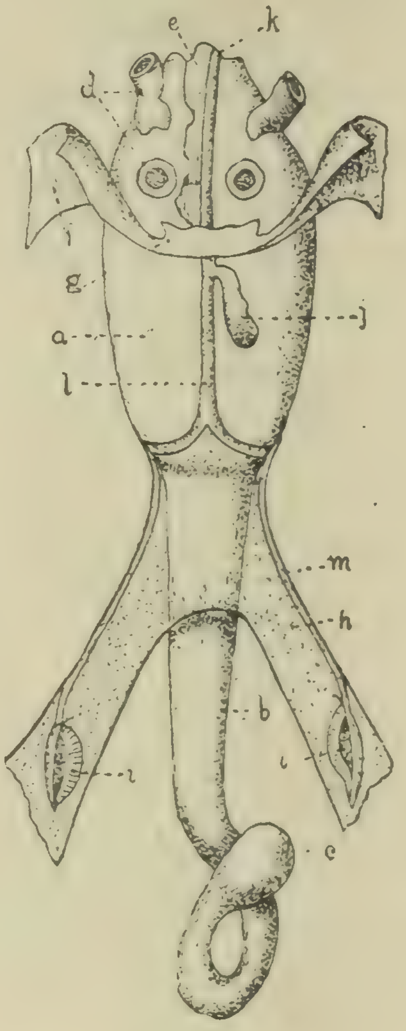


Fig. 126.—Alimentary canal of *Hemithyris psittacea*. *a*, stomach; *b*, intestine; *c*, imperforate extremity; *d*, hepatic ducts; *e*, dorsal mesentery; *f*, gastro-parietal bands; *g*, central band; *h*, ilio-parietal bands; *i*, oviducts; *j*, dorsal vescicle; *k*, *l*, vein; *m*, pallial sinuses. (Hancock.)

The entire tube is composed of firm tissue divisible into a fibrous outer coat and an inner mucous lining which is strongly plaited and wrinkled in the stomach and intestine. Externally it is sheathed by a tenuous membranous coat from

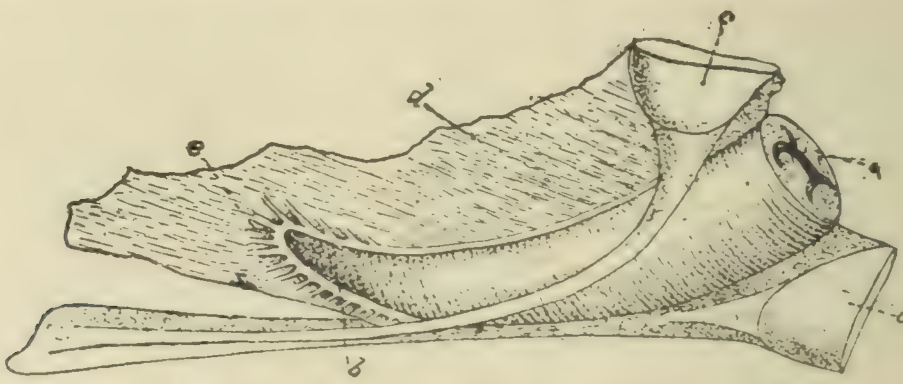


Fig. 127.—Intestine of *Magellania australis*. *a*, upper extremity; *b*, posterior cæca extremity; *c*, portion of oviducts; *d*, ventral mesentery; *e*, thickened ridges of mesentery; *f*, blood vessel. (Hancock.)

which is given off a number of mesenteric bands connecting with the walls of the perivisceral chamber. The stomach is usually enveloped by an ample *liver* of brownish or greenish hue lying

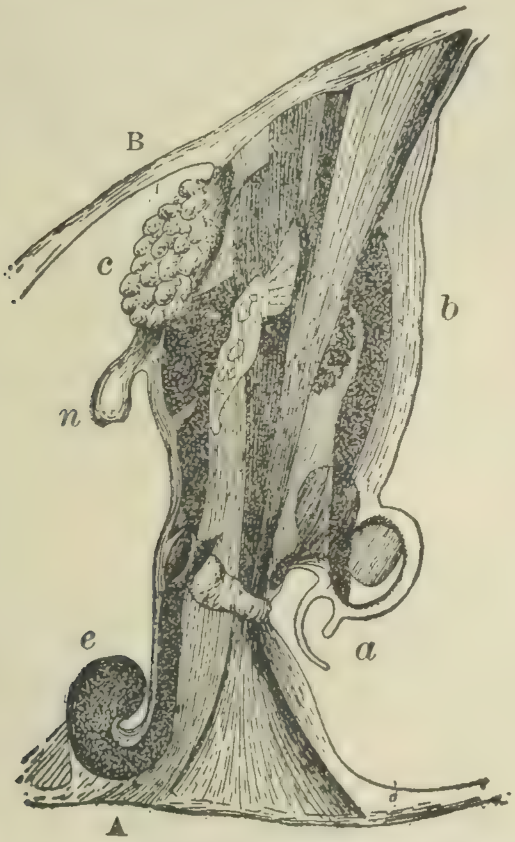


Fig. 128.—The alimentary and muscular system of *Rhynchonella* (*Hemithyris*) *psittacea*. (Huxley). *a*, mouth; *b*, œsophagus; *c*, stomach and liver; *e*, imperforate rectum; *n*, pyriform vesicle; A, pedicle-valve; B, brachial valve.

for the most part on the dorsal side, in the articulates, and on the ventral side in the inarticulates.

This glandular organ is composed of a varying number of cæcal tubes terminating in follicles or lobules, and discharging into the stomach at different points, usually at the sides. These hepatic canals would seem to serve in some measure a digestive function, as they have been found to contain the food of the animal, and, in Rhynchonella, to undergo peristaltic contractions of the tube-walls.

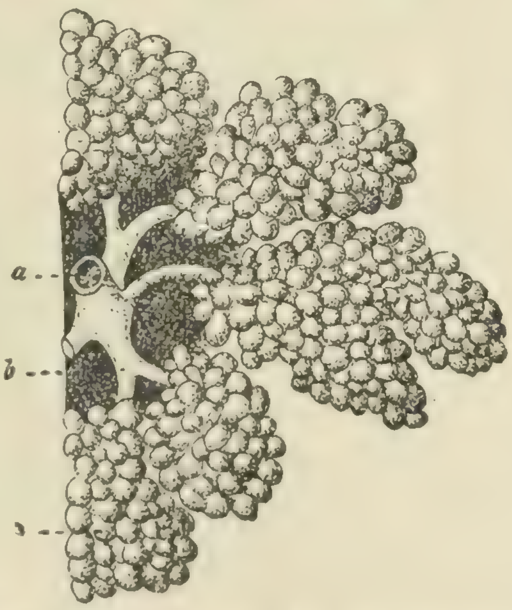


Fig. 129.—A portion of the liver of *Crania*. *a*, hepatic canals; *b*, canal of the lobules; *c*, lobules (Joubin.)

In a certain series of linguloid genera (Lingulops, Lingulasma, Trimerella, etc.) there appears to have been a gradual development of a testaceous thickening beneath the insertion of the muscular bands. This thickening or *platform* becomes slightly excavated on its anterior margin in Lingulops, more deeply in

Lingulasma, while in Trimerella and Dinobolus the platform is deeply vaulted. The development of these platform vaults does not proceed *pari passu* on both valves, but appears first and is always the deeper on the pedicle-valve. The upper surface of the platform always remains the area of muscular insertion, and it seems highly probable that the vaults have been formed by the necessity for the accommodation of the great hepatic and genital glands; there can be little doubt, at least, that when these chambers are fully developed they are occupied by these organs. A similar feature occurs in an aboloid genus, Lakhmina, and it is probable that among some of the articulate genera, where the anterior edge of the muscular area is conspicuously elevated (as frequently in *Leptæna rhomboidalis* and *Productus humerosus*) a similar cause has been efficient. Such structures are not to be confounded with excavations of the valves due to the deposition of shell-matter about the ends of the muscles, leaving the scars of the latter deeply sunk, as in many of the Spirifers. (Plates 23–28).

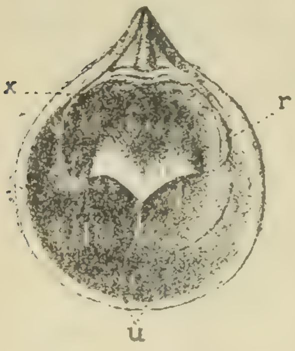


Fig. 130.—*Rhinobolus Davidsoni* Interior of pedicle-valve showing vaulted platform.

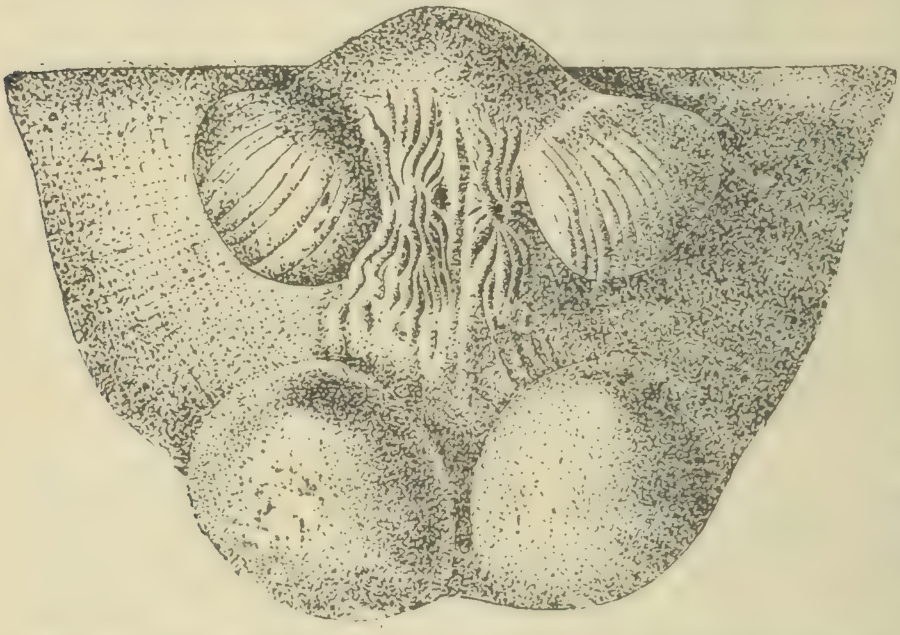


Fig. 131.—Cardinal view of an internal cast of the pedicle-valve of *Productus humerosus;* showing the filling of the great median cavities or vaults, lying in front of the muscular scars. (Davidson.)

Circulatory System.

The most striking and most distinctly specialized part of the circulatory system is the series of canals which traverse the mantle, lying within the tissue of the mantle itself. These canals consist generally of two main trunks diverging from the anterior portion of the perivisceral chamber and skirting the margins of the visceral area, giving off secondary branches and ramuscules which are abundantly multiplied at the margins of the mantle. These *pallial sinuses* are frequently so highly developed as to modify the inner surfaces of the valves, and traces of them are often retained when the latter are fossilized. In SCHIZOPHORIA there a few simple trunks restricted to the median portion of the valves, branching only at their extremities; in such shells the lateral expansions of the valves must have been nourished by sinuses too small to leave their traces on the valves.

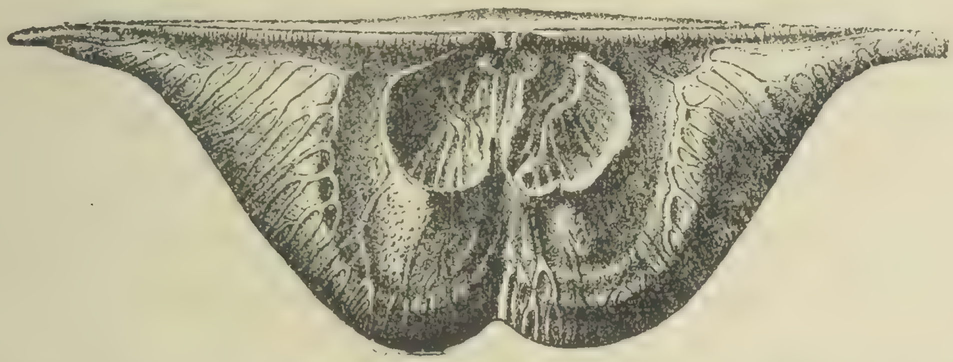


FIG. 133.—Interior of pedicle-valve of *Strophonella cœlata*; showing muscular impressions and pallial sinuses.

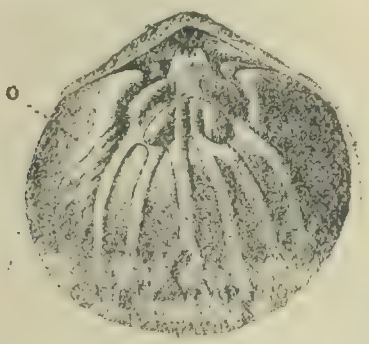


FIG. 134.—Internal cast of brachial valve of *Schizophoria impressa*. *v*, vascular trunks; *o*, genital markings.

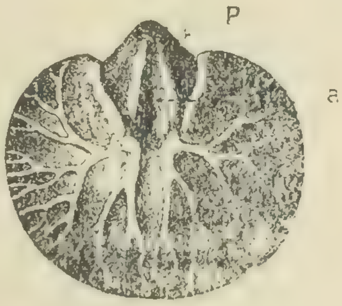


FIG. 135.—*Orthis subcarinata*. An internal cast, showing the pallial sinuses; *p*, impression of pedicle muscle; *a*, impression of diduductor muscles; *v*, vascular sinuses.

In CRANIA and CRANIELLA the sinuses are broad, digitate and not sharply defined, in the one; sinuous and without apparent connection with the other.

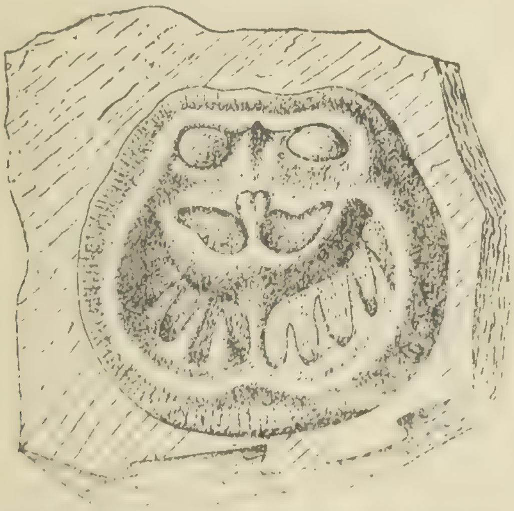


FIG. 136.—*Crania anomala*: showing the vascular and muscular impressions of attached valve. (DAVIDSON.)

In LINGULA and its allies there are two main trunks which converge toward the anterior margin of the valves, and give off not only an outer but a smaller inner series of branches. The main trunks of the pallial sinuses are the receptacles of a portion of the genital organs, but this fact does not interfere with their circulatory function. Similar canals traverse the fleshy brachia for their entire length. In Lingula there are three of these lying side by side; one very large and central, a much smaller one at the base of the cilia, the third being lacunary and lying in the brachial fold. In Crania and Rhynchonella the last-mentioned of these is absent. All the vascular sinuses pass into the perivisceral chamber and are developed into vescicular dilatations at the back of the stomach and elsewhere. These bodies are not contractile, and their function is at present unknown (Huxley). There is no pulsatile vescicle in the animal which performs the function of a heart, and circulation seems to be maintained by means of the ciliated tissue with which the sinuses are lined. Although there is no communication between these vessels and the walls of the perivisceral chamber, it is the opinion of some authors (Huxley) that these walls, which are also ciliated, contribute to this function.

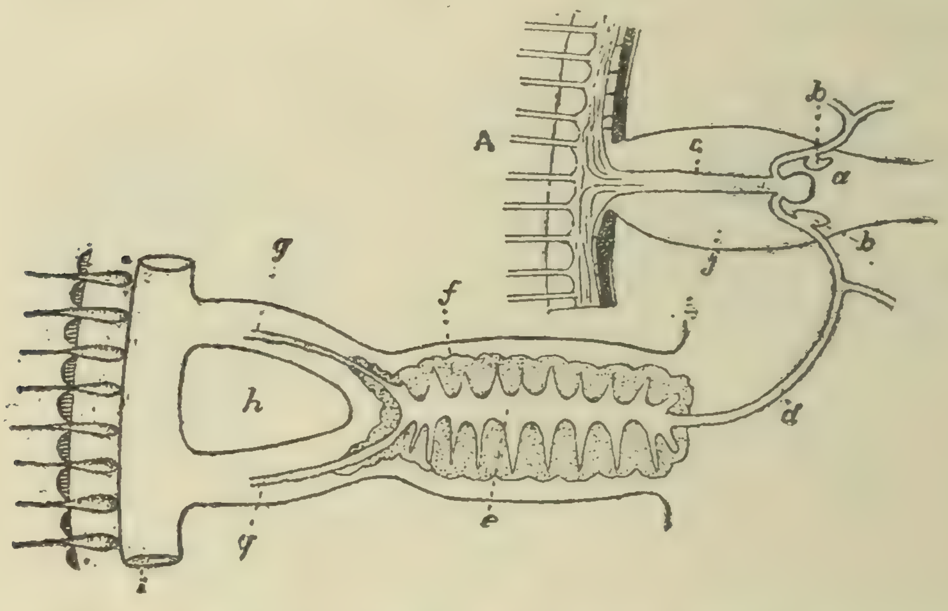


Fig. 137.—A portion of the circulatory system in *Magellania venosa.* Above the right is the ciliated oral surface (*A*), the stomach and intestine (*j*), upon whose dorsal surface is situated a central heart (*a*) sending an aorta (*c*) to the brachia, and giving off two lateral branches, each of which bears a pulsatile sac or subsidiary heart (*b*). The lateral vessels (*d*) supply the genital gland (*f*), and terminate (*g*) within the peripheral lacune (*i*) lying at the base of the setæ (*B*) which border the mantle (*h*). (Joubin.)

In Lingula, Morse has observed the existence of caecal extensions of the sinuses or *ampullæ* scattered over the inner surface of the mantle, which are highly contractile and receive and discharge the circulating fluid with perfect regularity.

As observed by Œhlert, "the body-walls, the oviducts and the genital glands are in direct connection with the blood; and the intestine, the muscles and the liver are enveloped by membranes so delicate that they can not obstruct the action of the nourishing fluid."

Respiration.

The function of respiration has no special organ or set of organs for its performance; it is not localized, but is evidently effected wherever the tenuous tissue of the animal with its circulatory vessels is exposed to the oxygenated water. The mantle is principally concerned in this function, and the long spiral brachia undoubtedly contribute, though perhaps not to the extent attributed to them by some authors, who have compared them to, and regarded them as branchiæ or gills.

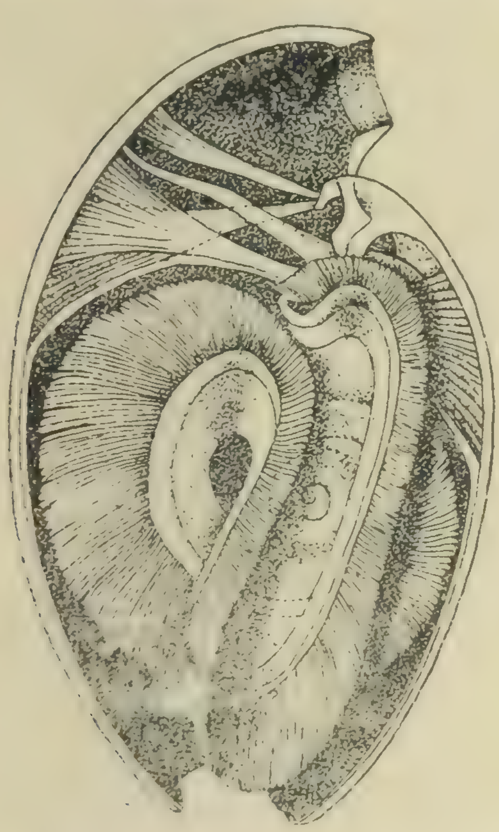


Fig. 138.—*Magellania flavescens;* showing the brachia. (Davidson.)

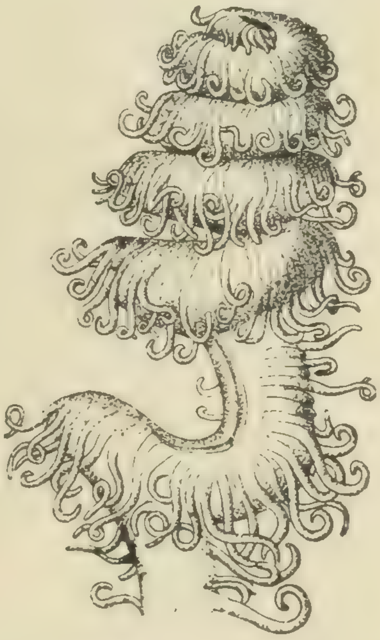


Fig. 139.—Extremity of the arm of *Crania*. (Joubin.)

The water entering the brachial chamber of the shells is constantly renewed by the opening and shutting of the valves, and perhaps more effectively by the constant play of the cilia with which the outer edges of the arms are fringed.

In this place a brief account of these arms, their variations in form and the nature of their calcified supports will be given.

Brachia. The brachia are labial appendages taking their origin about the oral opening and extending in various graceful curves and spirals into the anterior chamber of the valves. They are two in number, one at each side of the mouth.

These arms are substantially composed of a compact or cartilaginous tissue which is perforated for its entire length by several canals, to which reference has been made in the description of the circulating apparatus. The outer edge of the arms bears the *cirri*, which are kept in motion partly by muscular contraction and partly by the filling and emptying of the brachial canals. At the base of the cirri is a loose membranous expansion or flap, known as the brachial *fold* or *lever*.

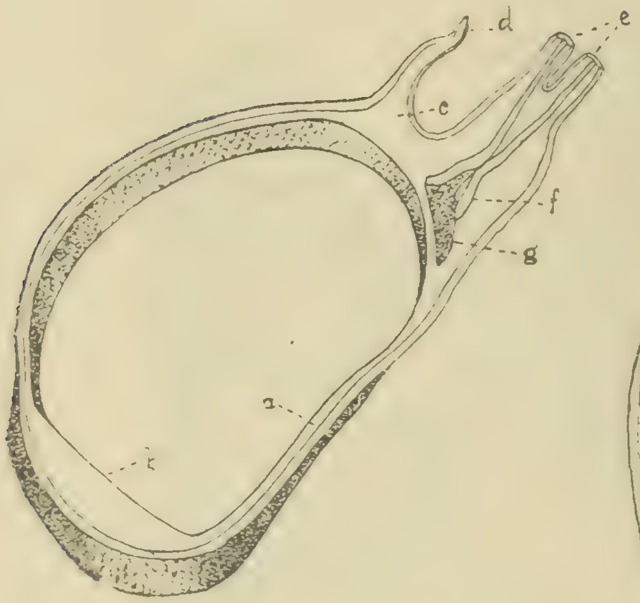


Fig. 140.—Transverse section of arm of *Hemithyris psittacea*. *a*, *b*, wall of great brachial canal; *c*, grooved ridge; *d*, brachial fold; *e*, bases of cirri; *f*, expanded orifices of cirri, opening into canal *g*. (Hancock.)

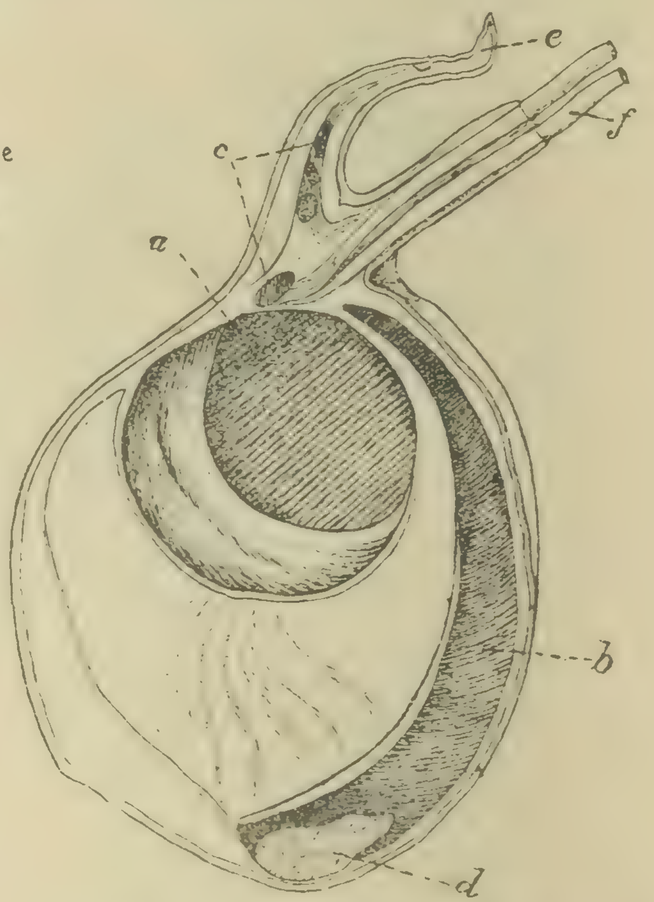


Fig. 141.—Transverse section of arm of *Lingula anatina*. *a*, central brachial canal; *b* posterior canal; *c*, lacunes; *d*, longitudinal muscle; *e*, brachial fold; *f*, bases of cirri. (Hancock.)

In a few of the living genera (Lingula and Rhynchonella) and in a great number of the extinct forms (Spirifer, Athyris, Rhynchospira, Rafinesquina, etc., etc., and probably Orthis) the arms are coiled in long spiral cones, the extremities of which may be directed outward (Spirifer, Athyris), inward (Rhynchonella, Zygospira), dorsally (Atrypa), ventrally (Amphiclina) or the spirals may be nearly in a vertical (Cyclospira) or a horizontal (Lingula) plane; and the number of revolutions in the spiral varies from two or three (LINGULA, CYCLOSPIRA) to twenty-five (*Spirifer mucronatus*).

In the majority of living forms (LIOTHYRINA, MAGELLANIA, MAGASELLA, MÜHLFELDTIA, KRAUSSINA, etc., etc.), the arms extend forward from the mouth or oral disk to the anterior margin of the valves, recurving toward the mouth, and there forming a short unpaired spiral in the axial line. While these are the principal variations in the arrangement of these parts, a notable difference is presented by MEGATHYRIS, THECIDIUM and their allies, in the complete attachment of the arm to the brachial valve by its lower margin. The area thus inclosed by the brachia is frequently large (*Megathyris decollata*) and it may be divided on its outer margin into three or more deep lobes. Living species whose brachia do not rest upon solid, calcified supports may possess the ability to uncoil and protrude the brachia between the open valves. This has been observed in RHYNCHONELLA (OWEN, MORSE), though it is doubtful if it is possible to the animal of LINGULA. In *Terebratulina caput-serpentis*, which possesses a short, solid brachial support, the animal can extend only the outer free margins of the arms and then but for a very short distance (BARRETT).

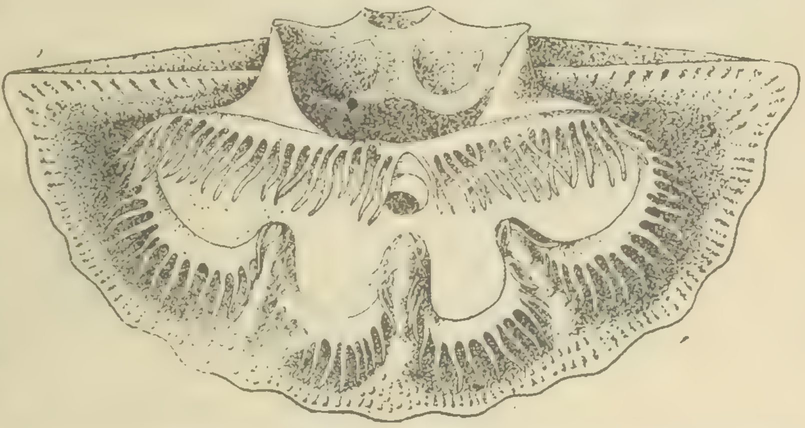


FIG. 142.- Brachial valve of *Megathyris decollata*, showing the arms attached by their lower margin about the expanded oral disk. (WOODWARD.)

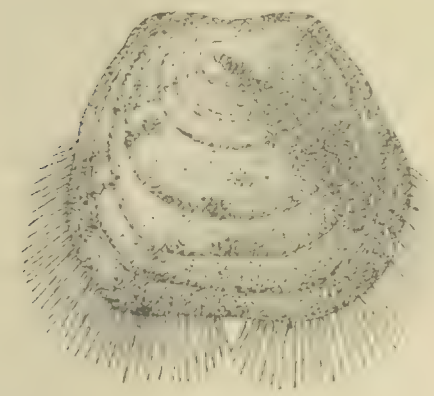


FIG. 143.-*Crania anomala*, with arms extended. (DAVIDSON)

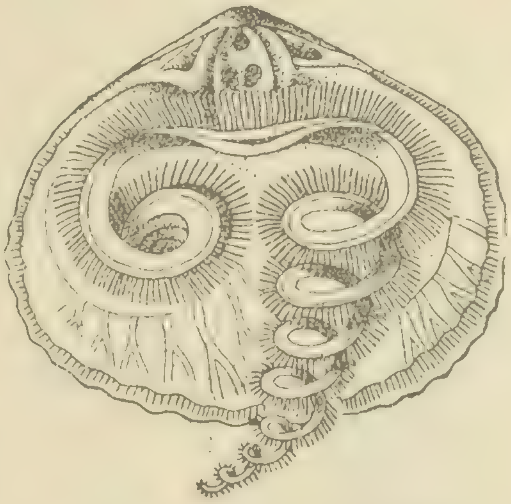


FIG. 144. — *Hemithyris psittacea*, with arm extended.

The ability of the brachiopods to form calcareous supports for the brachia may be regarded as degenerate in living species. Among extinct species, especially those belonging to the later Palæzoic and earlier Mesozoic eras, are to be found delicate and often exceedingly complicated supports, which were probably continuous with the fleshy arms for the entire extent of the latter. In Spirifer, for example, long spiral cones consisting of many revolutions of an exceedingly tenuous calcareous ribbon are frequently preserved with the utmost delicacy, and in Kayseria, Amphiclina and some forms of Athyris from the St. Cassian beds, these spirals are accompanied by an accessory pair, making four in all. The mode of union of these parts, their attachment to the valves and to the various supporting septa, are features of much significance, while the delicacy of such structures renders the determination of these points of great intricacy and difficulty.

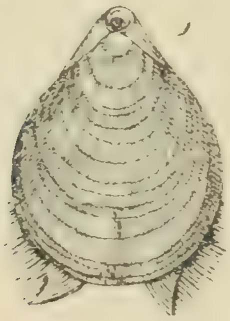


Fig. 145.—*Terebratulina caput-serpentis*, with arms extended. (Barrett.)

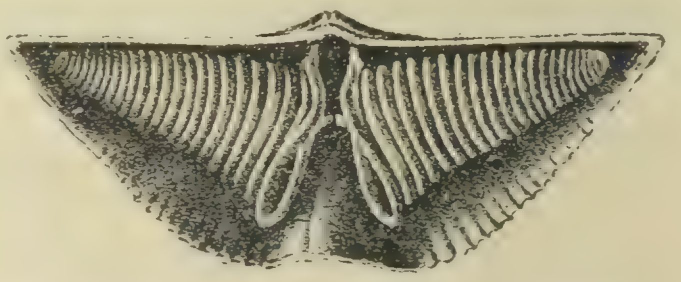


Fig. 146.—*Spirifer mucronatus*. Interior of brachial valve, showing spirals.

Such calcareous supports, which in any individual are known as the *brachiaium*, are formed by the interlocking and cementation of the spicules which are disseminatedthrough the canals and cirri of the brachia. The recent brachio pods possess only simple lamellar extensions which, in Terebratella, Magellania, Liothyrina and Terebratulina consist of two lateral processes. These may be united at their anterior extremity (Liothyrina, Terebratulina), or reflexed anteriorly, the union of the branches being median or posterior (Magellania, Terebratella.

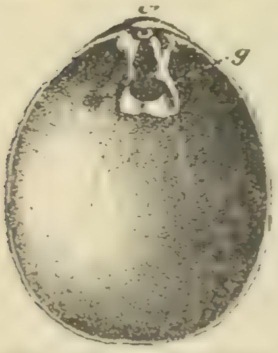


Fig. 147. — Interior of brachial valve of *Liothyrina vitrea*. c′. cardinal process: *g*. brachial supports. (Davidson.)

In all these cases the simple apparatus corresponds to only a portion of the first revolution of the ribbon in Spirifer, Rhynchospira, etc.

The size of the spiral cones and their direction varies to a certain degree equably with the form of the interior cavity of the valves. In species of SPIRIFER with greatly extended hinge-line the cones are very long and are directed toward the cardinal angles; where the hinge is short (MARTINIA) and its lateral angles rounded the cones are short or placed at oblique angles. In MERISTA, ATHYRIS, RHYNCHOSPIRA, MERISTINA, etc., etc., the axis of the spirals lies in the greatest transverse diameter of the shell. In ATRYPA the two flattened cones lie side by side, and their apices are directed into the cavity of the deep brachial valve.

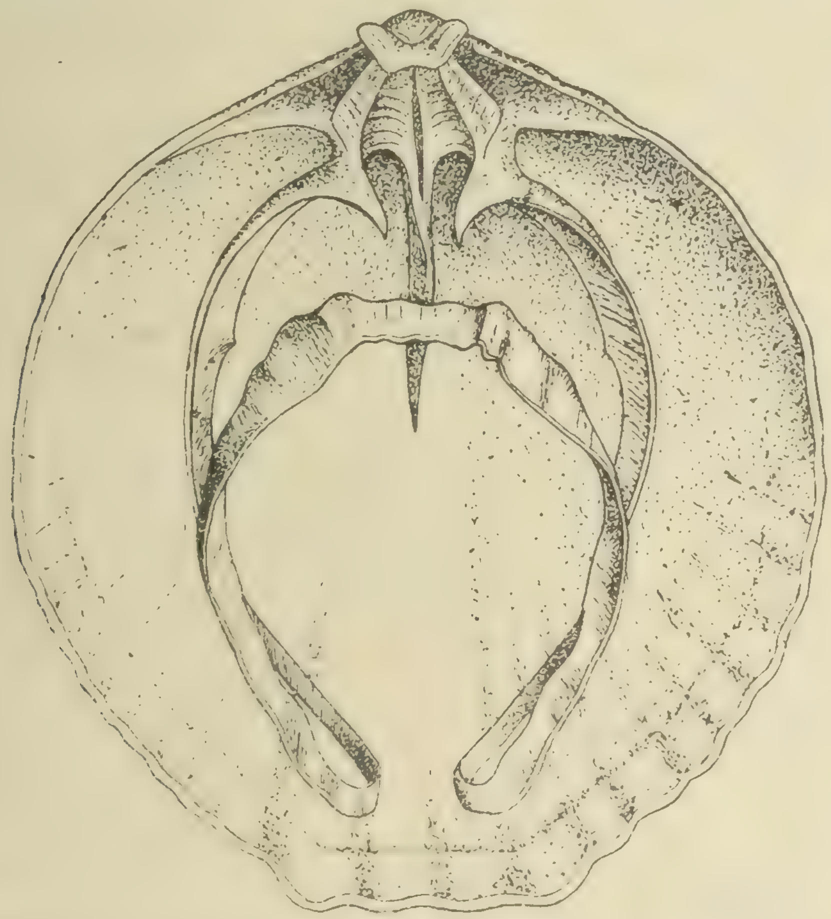


FIG. 148.—The brachial supports of *Magellania australis*. (HANCOCK.)

The brachial supports are attached to the hinge-plate, or apical portion of the brachial valve, by two processes termed *crura*. The precise termination of the crura and the commencement of the spiral ribbon is often obscure, but is frequently indicated by a sharp angle at the point of union and an abrupt widening of the ribbon directly behind it. (NUCLEOSPIRA, RHYNCHOSPIRA.) From this the curvature of the ribbon is downward into the cavity of the brachial valve, and the extensions of the ribbon for the first one-half revolution are termed the *primary lamellæ*.

In SPIRIFER the crura are very long, the bases of the spiral cones in this genus being small and situated well forward. The primary lamellæ are usually broader and stronger than the remainder of the coil and may be preserved in the fossil state when the rest is lost. These lamellæ, near the middle of their length, give off a pair of simple laminar processes which extend upward between the bases of the cones, and usually unite. When these processes thus unite the body formed is termed the *jugum;** when they do not unite, as in Spirifer, they may be called the *jugal processes.*

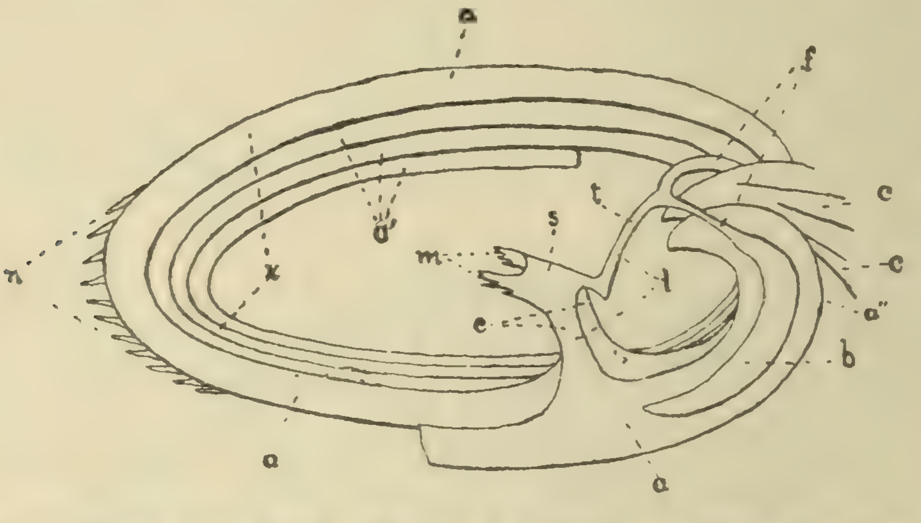


Fig. 149.— Diagram of loop and spiral *Athyris*; *x*, spiral; *a*, primary lamellæ; *a* , secondary lamellæ; *a″*, umbonal blades: *c*, crura; *l*, jugum; *e*, lateral branches of jugum; *s*, saddle; *m*, fimbriated extremity; *t*, stem of jugum; *f*, branches of jugum; *b*, intercalary lamellæ; *n*, fimbriæ on outer edges of spiral.

The function of this jugum is, unquestionably, in part to strengthen the entire apparatus and resist the strains to which the cones are exposed from gravitation and other causes. It is therefore remarkable that Spirifer, in which the cones reach

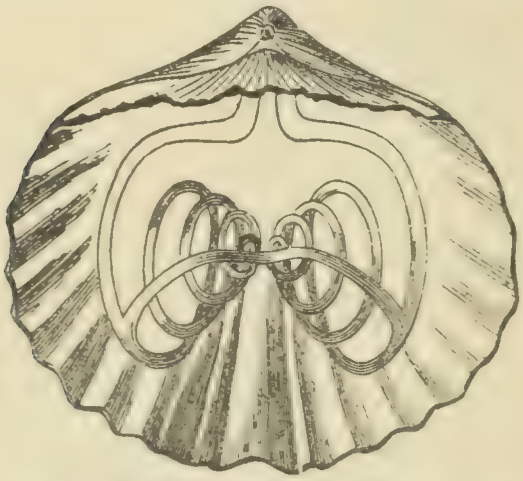


Fig. 150.— *Zygospira modesta.* The brachidium exposed by the removal of the brachial valve, showing the jugum.

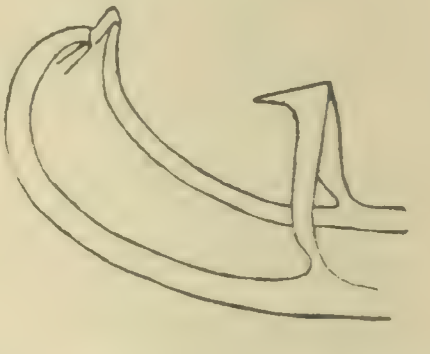


Fig. 151.—Jugum of *Trematospira multistriata*, attached to a portion of the primary lamellæ.

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* This organ has usually been termed the *loop*, but the use of this term among the brachiopods with calcified spirals causes obscurity and confusion, as the word was originally applied to the entire brachial support in the terebratuloids, and it must continue to be used with this meaning while the relations of the true *loop* to the *jugum* of spire-bearing shells is that of a whole to a part.

their greatest development, is always devoid of this support, and equally noteworthy that this genus, which seems poorly adjusted against such strains when compared with other spire-bearing genera, should have maintained so long and so prolific a development without variation in this respect.

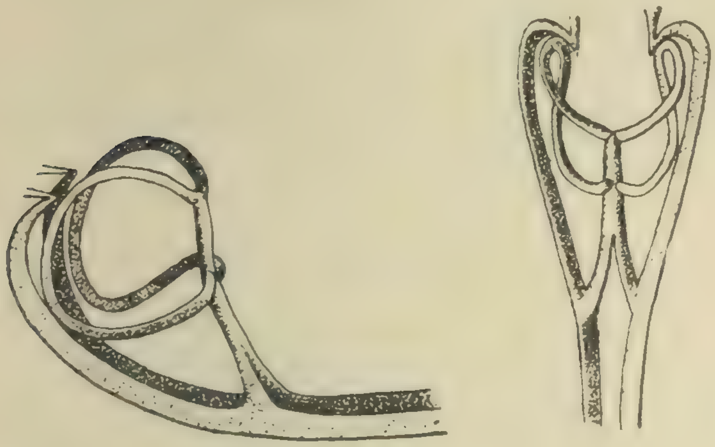


Fig. 152.—Jugum of *Meristella arcuata.*

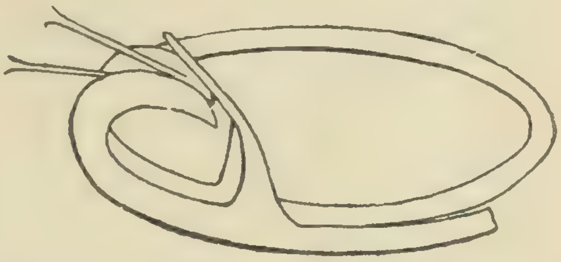


Fig. 153.—Jugum of *Nucleospira ventricosa.*

The jugum does not end at the point of union of the two lateral jugal processes, but is more or less continued, in its simplest form, into a short, straight stem, inclined backward and terminating in an acute angle (Retzia, Rhynchospira, Whitfieldella); in Bifida this stem is long and extends to the inner surface of the pedicle-valve where its extremity is inserted into a deep groove in the shell. In Eumetria and Meristina the

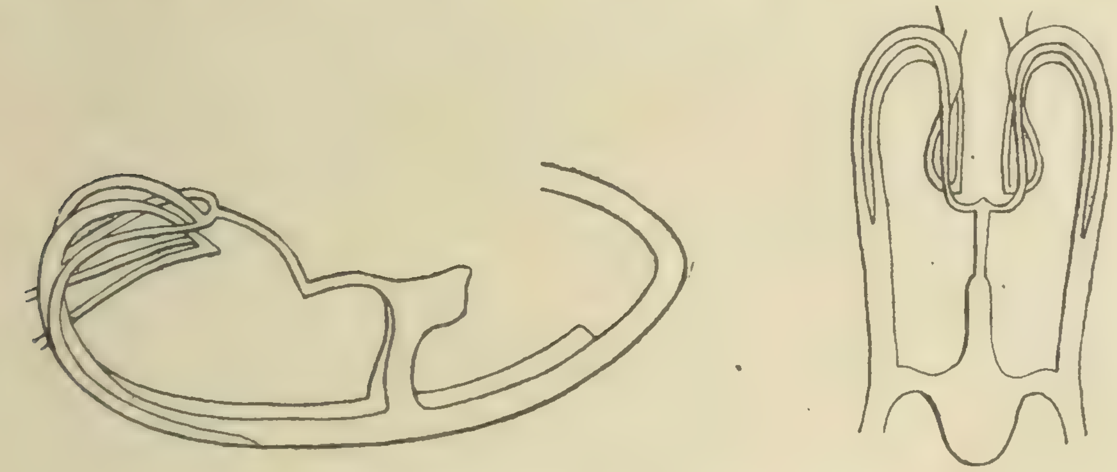


Fig. 154.—Jugum of *Athyris vittata.*

Brachial apparatus of *Bifida lepida.*

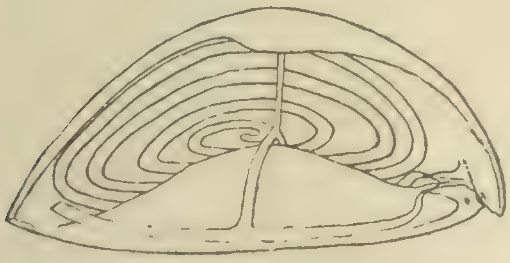


Fig. 155.—Longitudinal section.

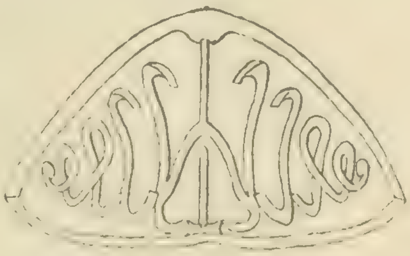


Fig. 156.—Transverse section.

extremity of the stem is bifurcate, but the terminal processes do not extend beyond the ends of the crura: while in ATHYRIS, TETRACTINELLA and AMPHITOMELLA they are continued backward between the primary and secondary lamellæ for about one fourth of a revolution. In PEXIDELLA the intercalary lamellæ are still longer: in AMPHITOMELLA, KAYSERIA and AMPHICLINA they are continued for the entire length of the spiral cones thus making a double spiral on each side. In MERISTA and MERISTELLA the

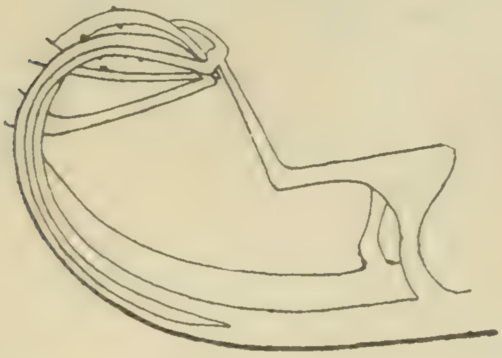


FIG. 157.— Jugum of *Athyris spiriferoides.*

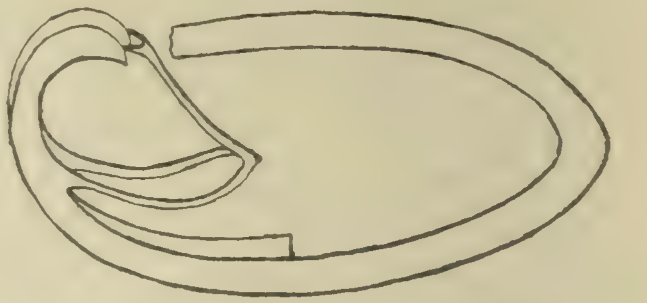


FIG. 158.—Jugum of *Eumetria Verneuiliana.*

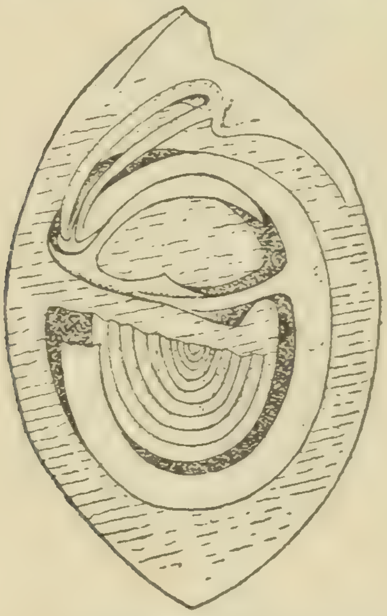


FIG. 159.— Loop of *Tetractinella.* (BITTNER.)

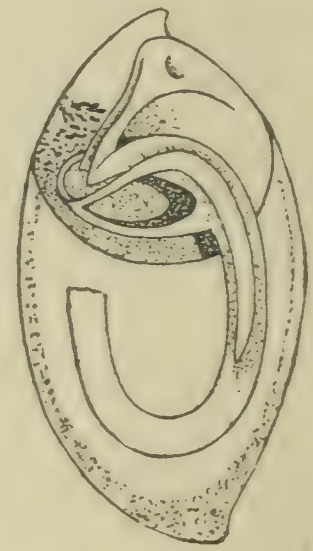


FIG. 160.— Loop of *Amphitomella.* (BITTNER.)

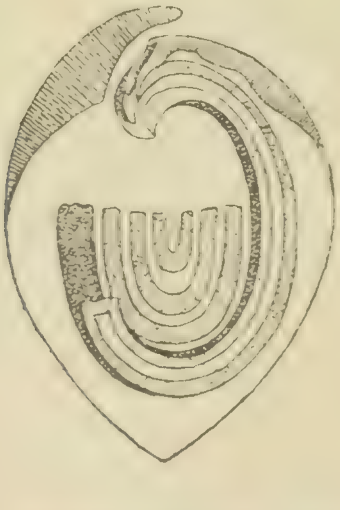


FIG. 161.—Loop of *Pexidella.* (BITTNER.)

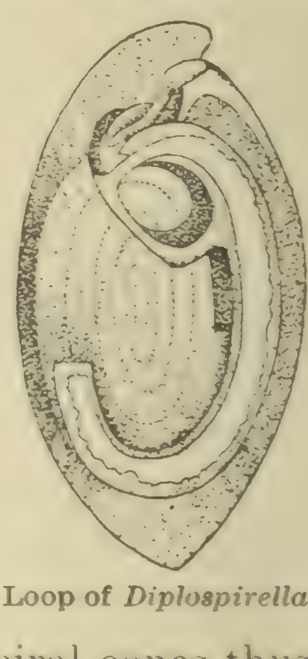


FIG. 162.— Loop of *Diplospirella.* (BITTNER.)

divisions of the stem of the jugum, or intercalary lamellæ, are short, recurving and joining the lateral processes near their union.

This place of union of the lateral branches of the jugum is frequently somewhat thickened and expanded (Retzia, Rhynchospira, Uncites) and in Athyris it is a broad, saddle-shaped structure. In the last genus the posterior margin of this *saddle* is sometimes fimbriated, and not infrequently similar fimbriæ or spinules are retained on the outer posterior edges of the primary and secondary lamellæ; these have also been observed in Atrypa, Ambocoelia, Dayia, etc. These spinules undoubtedly result from the network of spicules deposited in the cirri of the brachia.

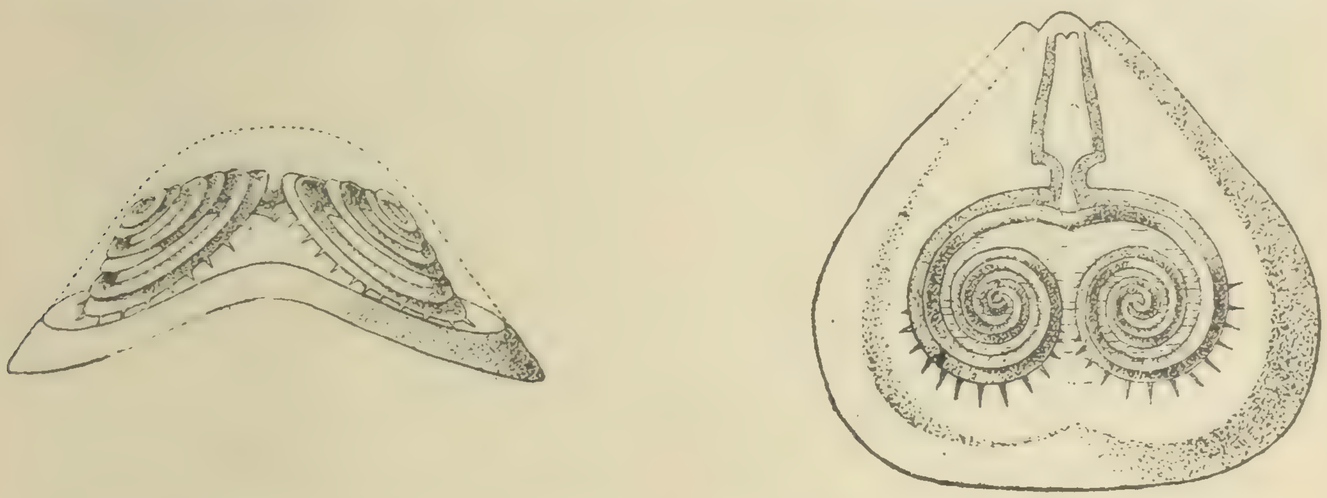


Fig. 163.—Brachial apparatus of *Koninckina*, showing the double spirals. (Bittner.)

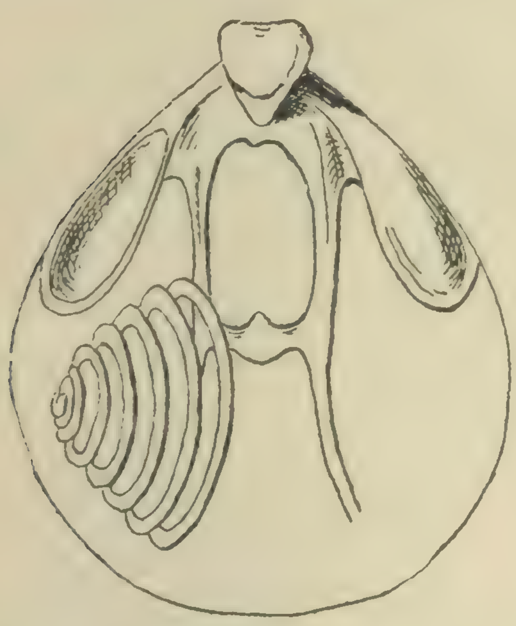


Fig. 164.—Loop and spiral of *Uncites gryphus*. (Davidson.)

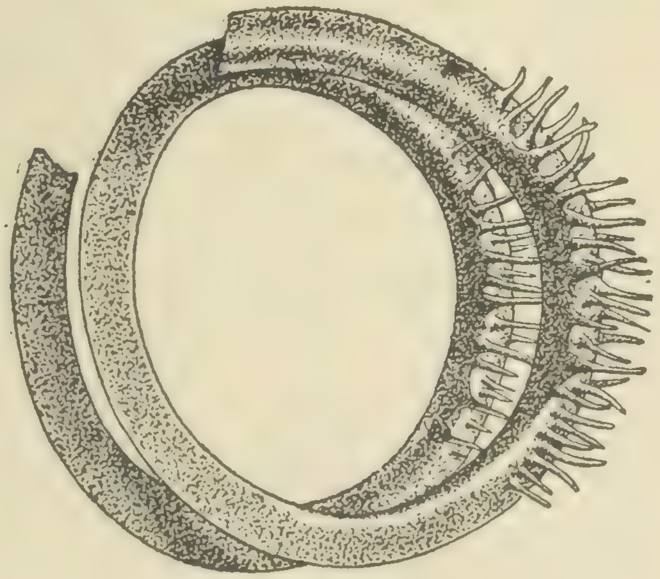


Fig. 165.—Portion of spiral of *Spiriferina rostrata* showing the fimbriæ on the outer margins of the coils. (Davidson.)

The jugum is often in close relation with the median septum of the brachial valve. Perhaps in no case among the spire-bearing species is there an actual union of these parts, such as is so frequent among the terebratuloids; but in several general Meristina, Kayseria, Bifida, a high median septum rises so close to the angle of the jugum that but a very slight depression of the entire brachial apparatus would cause it to rest upon the septum and thus secure an efficient support. Whether this septum has been at all concerned in the modifications to which the spirals have been subjected in growth has yet to be determined. In genera, where the spirals are convergent rather than divergent, Atrypa, Zygospira, Glassia etc., the jugum is always simple in

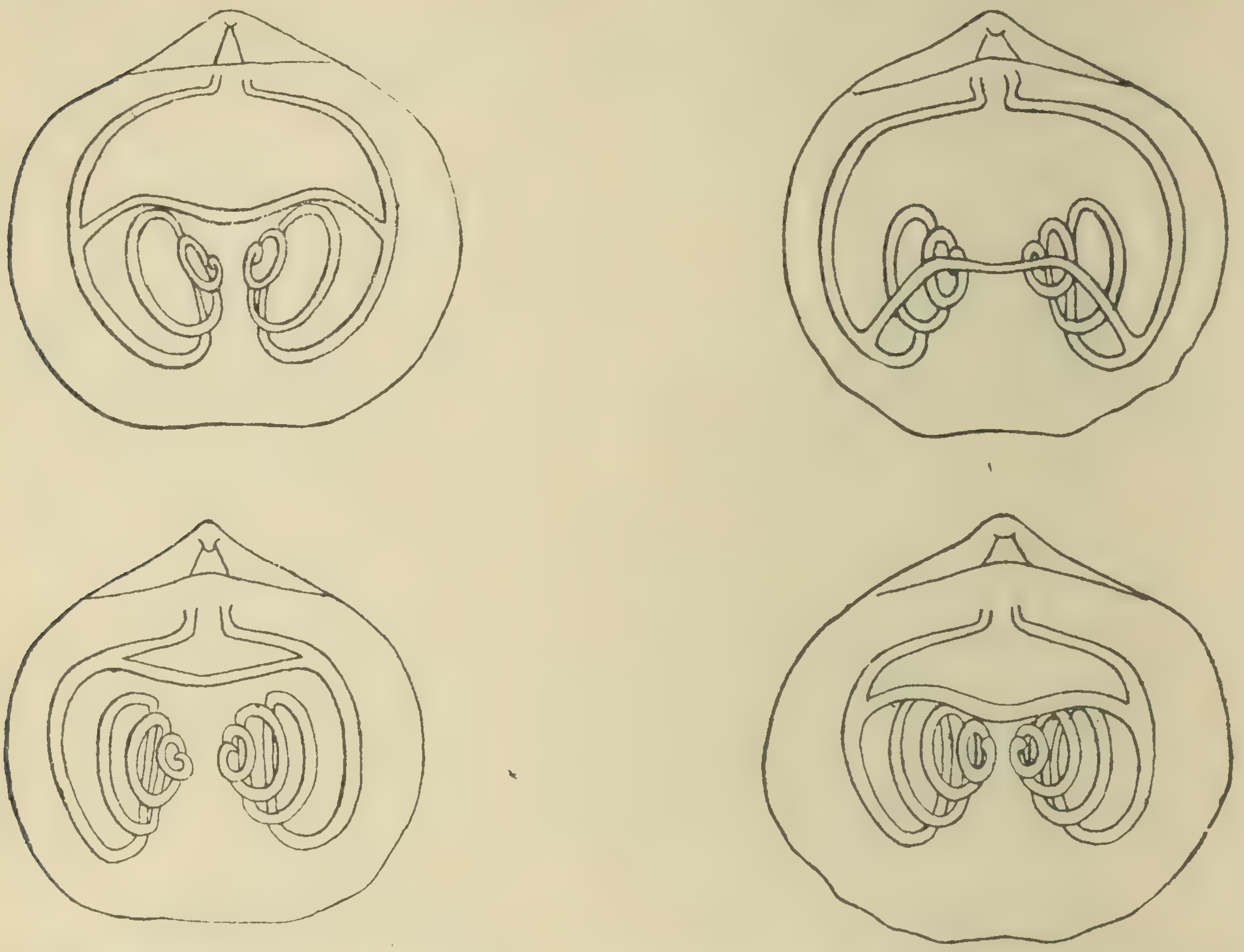


Fig. 166.— Brachial apparatus of *Zygospira modesta*, showing the variation in the position of the jugum.

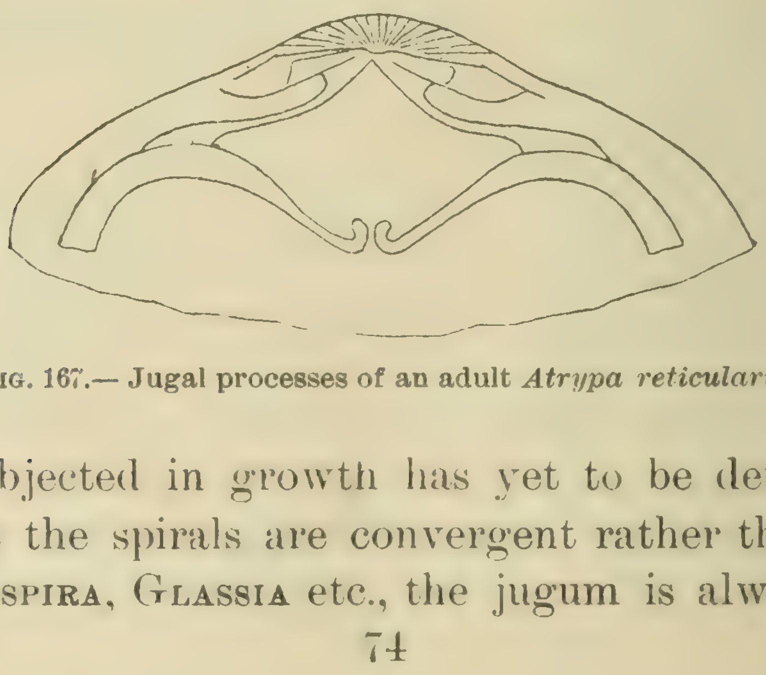


Fig. 167.— Jugal processes of an adult *Atrypa reticularis.*

its structure. Atrypa, with its spirals directed upward into the cavity of the brachial valve, has its jugum situated posteriorly and is composed of two lateral branches directed anteriorly, and slightly upward in the middle. In early growth-stages this is a continuous band, but in mature or senile conditions of growth it becomes divided in the middle (probably from the lateral strains to which it is subjected) and the extremities of the jugal processes become much thickened. In Glassia the spirals have their apices at the center of the internal cavity and their bases at the sides: the jugum is a short posterior transverse band. In Zygospira the variation in the position of the jugum in a given species (e. g., *Z. modesta*) is remarkable, it being sometimes posterior, at

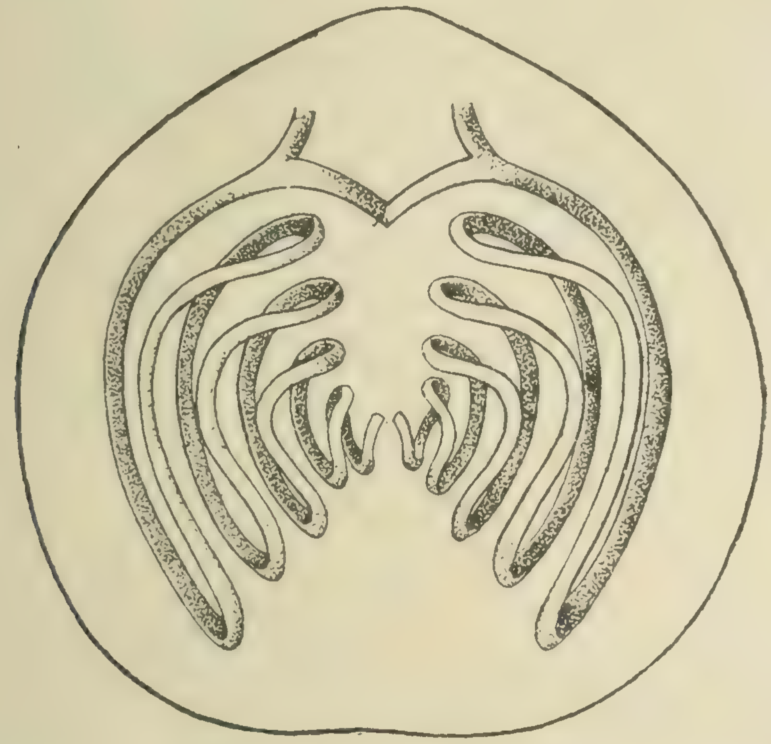


Fig. 168.— Brachidium of *Glassia obovata*, showing the posterior position of the loop. (Davidson.)

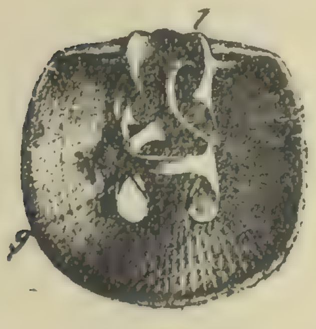


Fig. 169.— Brachial valve of *Megerlia truncata*. *g*, loop; *l*, septum. (Davidson.)

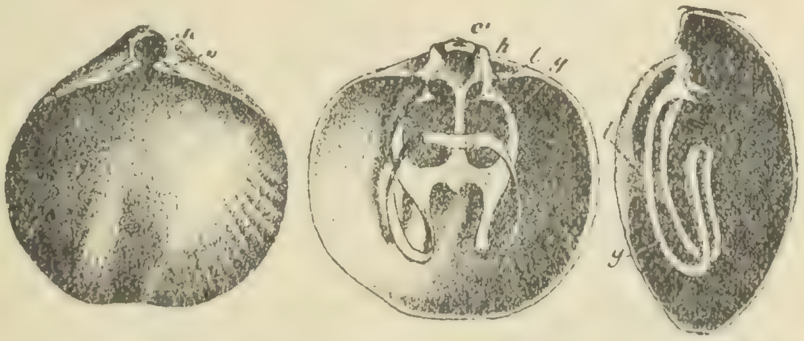


Fig. 170.— *Terebratella dorsata*. *n*, foramen; *o*, deltidial plates; *c'*, cardinal process; *h*, hinge-plate; *l*, septum; *g*, brachial supports. (Suess.)

others median, and again anterior, curving forward in the first case and backward in the last.

In the non-spiriferous brachiopods, or those in which the brachial apparatus is abbreviated, we usually find a simple representation of the primary lamellæ and the jugum which may be variously complicated with the median septum of the brachial valve. In this group the entire calcified apparatus is termed the *loop*, which is typically composed of two long or short primary or *descending lamellæ* which may recurve more or less profoundly at their anterior extremity (*ascending lamellæ,*) and unite in a transverse band. This last is the homologue of the jugum. In TEREBRATELLA, TEREBRATALIA, MÜHLFELDTIA, ISMENIA, and some other genera, the descending lamellæ are united to the median septum by a dorsal band, which is a residuum resulting from progressive resorption of the calcareous parts, and wholly disappears in more advanced forms, such as *Magellania venosa*. In typical forms of MAGELLANIA the septum also has disappeared and the loop in the adult condition is without any evidence of former connection with the valve, except at the hinge-plate. A corresponding adult condition is found in the palæozoic genera CRYPTONELLA, MEGALANTERIS DIELASMA, etc. In CENTRONELLA and RENSSELAERIA the primary lamellæ simply unite at their anterior extremities without reflection, the apparatus here being expanded into a triangular plate. A somewhat similar arrangement is seen in MAGAS and PLATIDIA, while in BOUCHARDIA, KRAUSSINA, little is left of the brachial sup-

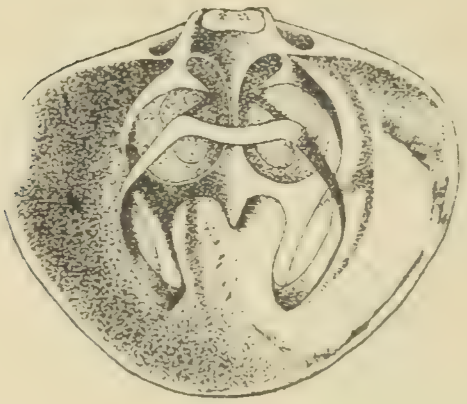


FIG. 171.— *Terebratalia dorsata*. (WOODWARD.)

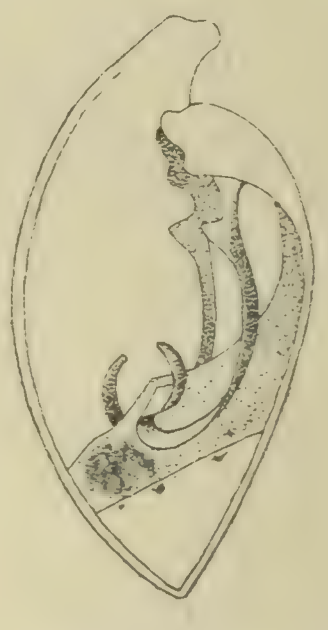


FIG. 172.— *Magasella Cumingi*. (DAVIDSON.)

ports but the median septum and the portions of the loop attached to its anterior extremity.

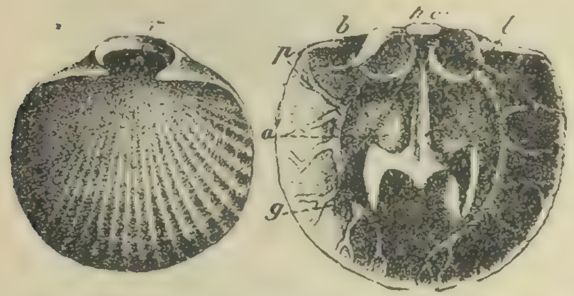


Fig. 173.—*Kraussina rubra.* *n*, foramen; *hc*,′ cardinal process; *a*, *b*, adductors; *p*, pallial sinuses; *g*, brachial supports; *l*, septum. (Davidson.)

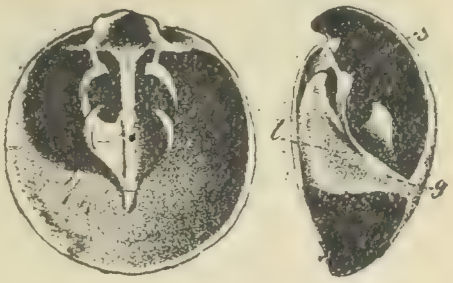


Fig. 174 — *Magas pumilus.* *b*, median septum; *g*, brachial supports. (Davidson.)

Of Palæozoic genera Tropidoleptus alone has afforded evidence of actual connection in the mature state of the descending lamellæ with the median septum, a condition of the brachial apparatus comparable to that of Platidia among living forms.

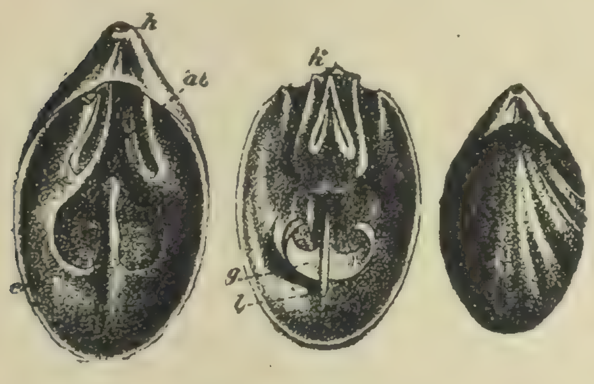


Fig 175.—*Bouchardia rosea.* *h*, foramen; *ab*, adductors; *e*, diductors; *k*, cardinal process; *g*, brachial supports; *l*, septum.

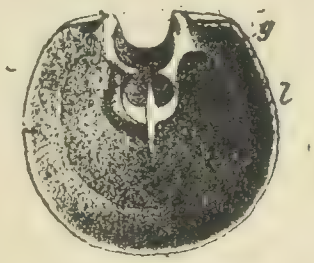


Fig. 176. — Brachial valve of *Platydia anomioides.* *g*, loop; *l*, median septum. (Davidson.)

In many of the terebratuloids the union of the crura and primary lamellæ is represented by sharp crural angles directed inwardly. In Liothyrina, which has the entire supporting apparatus remarkably abbreviated, these angles are conspicuous, while in Terebratulina they unite to form a continuous band. In the Devonian genus Stringocephalus, the crura are very long, the loop absent, and the lamella very broad and situated just within the margin of the brachial valve; from it extends a series of filamentous processes, which are directed towards, and may have been attached to the crura.

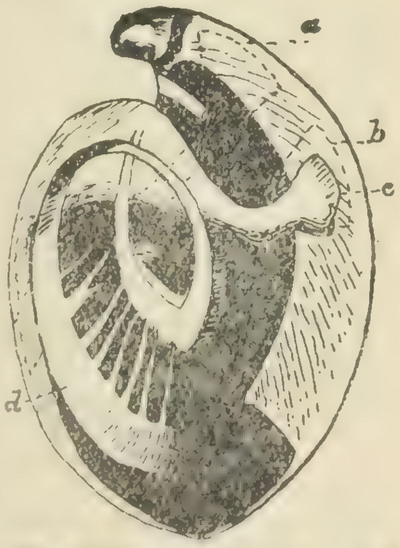


Fig. 177. — Muscular and brachial apparatus of *Stringocephalus Burtini.* *a*, adductors; *b*, diductors; *c*, cardinal process; *d*, brachial support. (Hoernes.)

The species in which the lower surface of the brachia is attached to the mantle, have a simple vertical lamella (Cistella), which may be lobed (Megathyris, Bactrynium, Eudesella, Davidsonella, etc.). In Thecidium, Thecidella, Lacazella, etc., the definition of the lamella is obscured, the spicular network being loose and sponge-like. The brachiopods which were not possessed of elaborate brachial supports may have long calcareous crura, as in Rhynchonella and its allies, or even these may be wanting, as in Strophomena, Plectambonites and Productus. Such shells, however, sometimes retain grooved impressions made by the spiral arms upon the inner surface of the valves (Davidsonia, Rafinesquina) In Chonetēs and Productus there are two divergent impressions on the brachial valve, which are commonly known as the *reniform markings*, and these are generally regarded as due to the brachia, though their precise relation to these organs has not been satisfactorily explained.

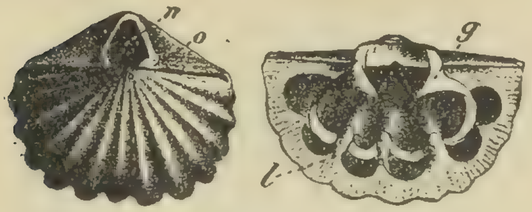


Fig. 178. — *Megathyris decollata*. *n*, foramen; *o*, deltidial plates; *g*, crura; *l*, lobed extension of brachial supports. (Bronn.)

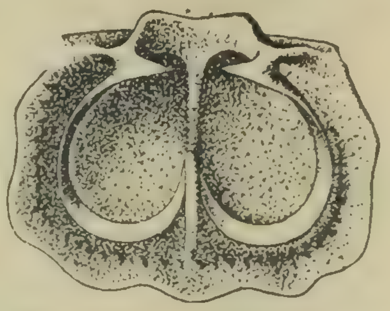


Fig. 179. — *Cistella neapolitana*. Interior of brachia-valve. (Woodward.)

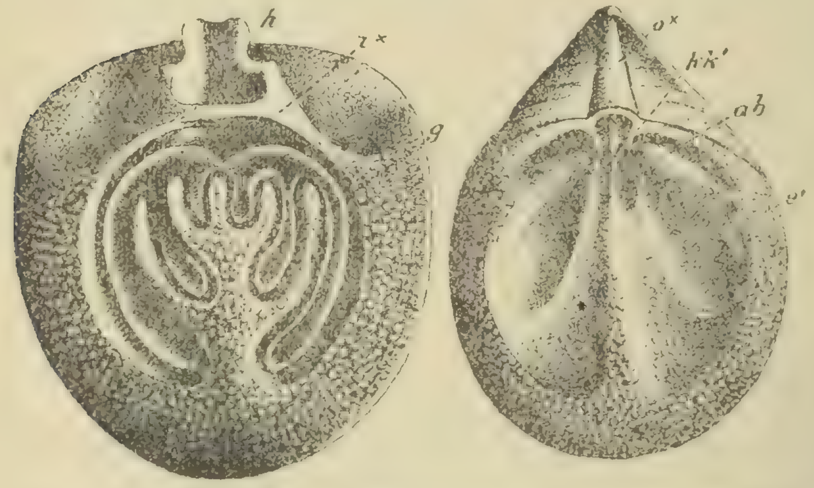


Fig. 180.— Interior of brachial and pedicle valves of *Thecidium radiatum*. *o′*, deltidium; *kk′*, teeth; *ab*, adductors; *e′*, diductors; *h*, cardinal process; *i′*, cardinal plate; *g*, brachial supports. (Suess.)

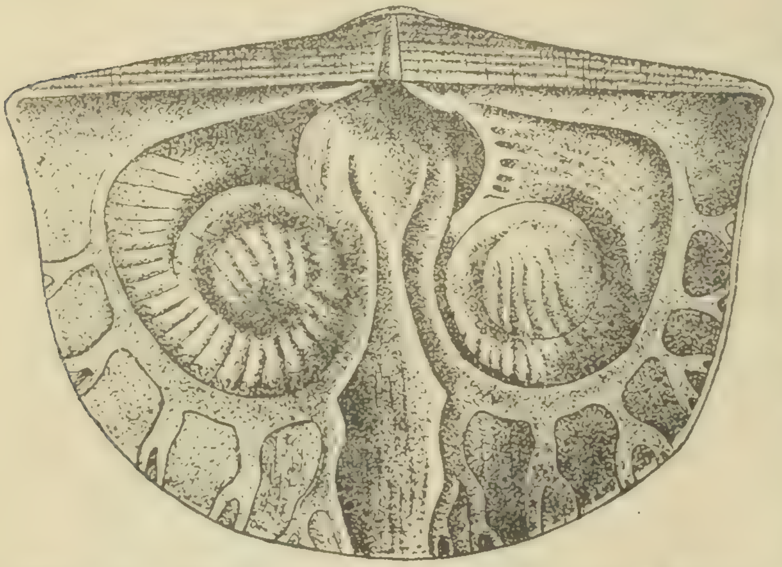
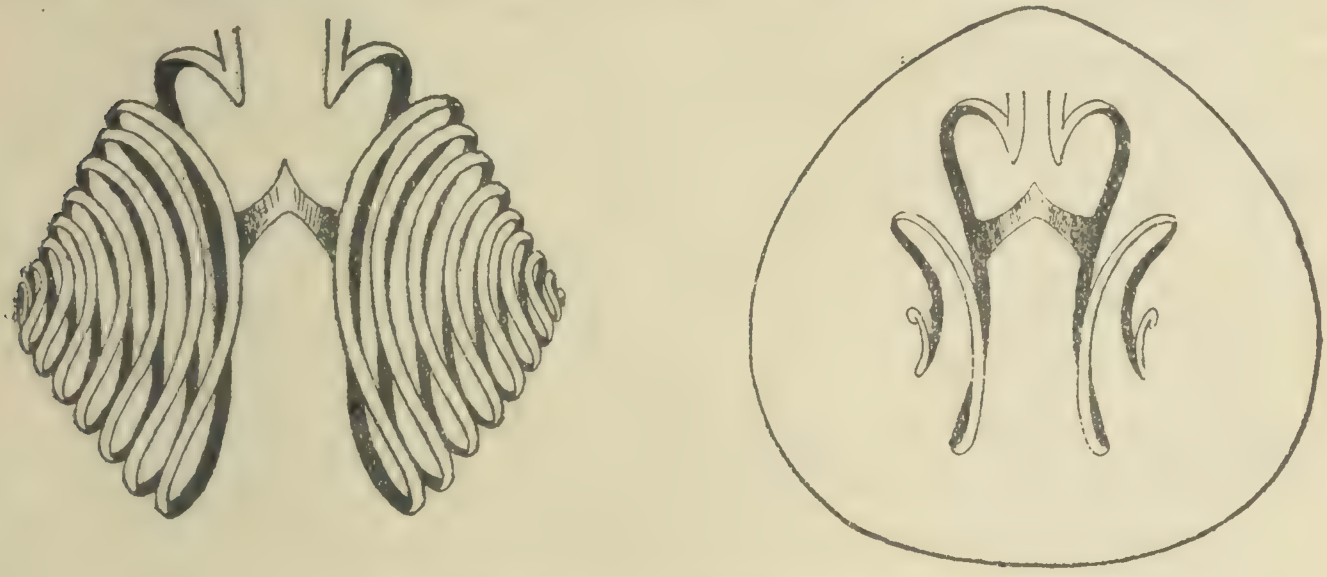


Fig. 181. – The interior of the pedicle-valve of *Rafinesquina Jukesi*, showing the impression of the spiral arms. (Davidson.)

Upon the mode of development and growth of the brachia and supporting apparatus some important observations have been made.

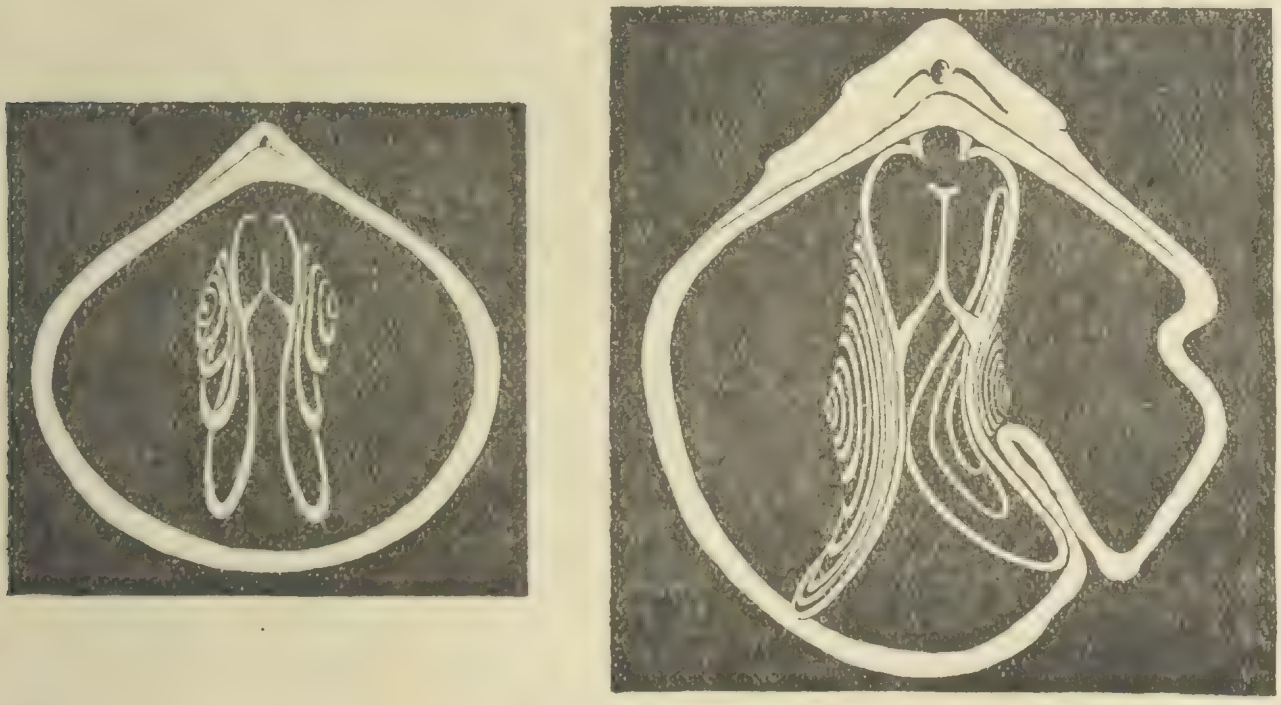
Morse has shown that in early stages of Terebratulina the arms are simple or double horse-shoeshaped processes, quite like the lophophore of the Bryozoa. The same author also demonstrates that the formation of the crura and brachial supports is a gradual and permanent accretion, growth taking place on both sides until union is effected and the support thus completed.



Rhynchospira (Homœospira) evax.

Fig. 182.—The mature condition of the brachidium.

Fig. 183—The brachidium in a very early stage of growth; in this figure the form of the jugum is wholly constructive. (Beecher and Clarke.)



Meristina Maria.

Fig. 184.—The brachidium in a very early condition of growth; showing the lax revolutions of the ribbon and the depressed spiral cones.

Fig. 185.—The brachidium in a young shell, showing a distortion in one of the spirals caused by an obstruction to the peripheral growth on one side of the valves, which has apparently produced no disturbance of function in the brachia.

Among the spire-bearing forms it has been shown that in the young of *Rhynchospira* (*Homœospira*) *evax* the ribbon is very slender and makes but a few and very lax revolutions. The same fact is evident in the young of *Meristina Maria* (as shown in the accompanying figures), where the revolutions are few and the spiral cones depressed. The growth of these solid bodies and the increase in number of the revolutions could be effected only by constant resorption and redeposition of the spicular calcareous secretions from the brachia.

Kovalevski, Friele, Deslongchamps, Œhlert, Beecher and others have given accounts of the development of the brachia in Cistella and some of the higher genera of the *Terebratellidæ* (Terebratella, Magellania, Macandrevia, Dallina, Terebratalia). In the early stages of such shells the brachia have the form of a circlet, extending forward from about the mouth, bearing a few tentacles or cirri, which are directed inwards. This condition is comparable to the adult condition in Gwynia and has therefore been termed the *gwyniform stage*. By the development of a median septum in a succeeding stage of growth this circlet becomes inflected medially and the resultant condition is that of the adult Cistella (*cistelliform stage*). With the further growth of the septum and the development of its lateral processes the brachia gradually take on the form of the mature Platidia (*platidiform stage*), the cirri finally becoming everted, and the median unpaired arm resulting from the continued growth of the basal cartilage and the multiplication of the cirri at the distal extremities of the brachia.

These developmental stages are still more clearly exemplified in the formation of the loop or calcareous supports. Among the *Terebratellidæ* there is one group of boreal forms (*Dallininæ*) and one also of austral forms (*Magellaninæ*), all agreeing in having the loop, in its final condition, composed of long descending and ascending branches in no connection with the median septum. In the boreal forms (Macandrevia, Dallina) the development of the loop has passed through a series of stages corresponding successively with the adult condition in Platidia, Ismenia, Mühlfeldtia and Terebratalia, while in the austral group (Magellania) the preliminary stages are reproduced in the adult Kraussina, Bouchardia, Megerlina, Magas, Magasella and Terebratella, successively. The larval conditions of the terminal members of both series are similar to the adult condition of the simplest members of the family, Cistella and Gwynia.

Thus similar resultants have ensued in this family by progressive growth and resorption of the brachial supports through quite dissimilar lines of development.*

From the study of young stages in a Carboniferous species, *Dielasma turgida*, a terebratuloid with short, recurved loop, and in the Silurian species, *Zygospira recurvirostra*, a spire-bearing shell with introverted cones, it has been demonstrated† that in the earliest observed conditions of both, the brachidium consists simply of the two lateral or descending lamellæ, united in front, forming an expanded triangular plate like that in Centronella and Rensselaeria.

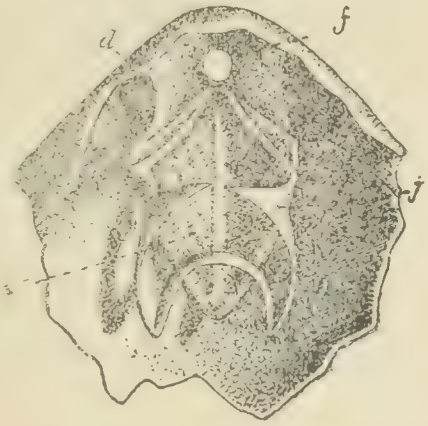


Fig. 186 — *Dielasma elongatum.* *f*, foramen; *j*, jugal processes; *d*, dental plates; *m* muscular impression.—(Davidson.)

Resorption of the anterior portion of this plate gradually produces the ascending and transverse lamellæ of Dielasma and the jugum of Zygospira; parts which are thus seen to be alike in origin and function. With Dielasma the process here ceases, but in Zygospira there is a continuation of the lamellæ carried forward from the ante-lateral angles of the loop, which, with growth takes on the spiral form of the mature brachia. The inference from this evidence is that the Centronella-loop is of the simplest type; anything more elementary would represent the condition of the descrete crural processes in Rhynchonella. The recurved loop of the terebratelloids is a more advanced condition of this organ, while the spiral brachidium, attained so abundantly and with such diversity, during Paleozoic and early Mesozoic time, represents its most elaborate development.

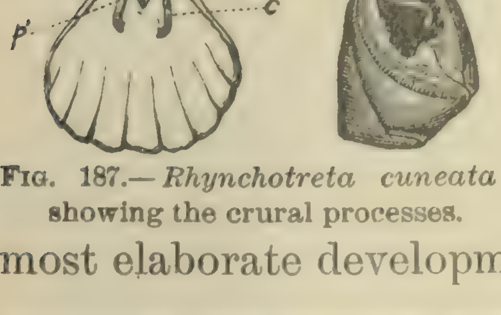


Fig. 187.— *Rhynchotreta cuneata*; showing the crural processes.

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*These interesting facts have been established by the investigations of Friele, Œhlert, Fischer and C. E. Beecher.

†Beecher and Schuchert; Proceedings of the Biological Society of Washington, vol VIII, 1893.

THE NERVOUS SYSTEM.

The nerve-collar surrounding the œsophagus constitutes the principal nerve mass in the Brachiopoda. In the articulate species there is a large ganglion (subœsophagian) on one side of the œsophagus, connected by fine lateral commissures with a smaller ganglion on the opposite side. In the inarticulates (LINGULA, CRANIA) so far as ascertained, the upper and lower ganglia are not so well developed, the nerve-ring being of more equal size throughout. From the swellings of the œsophageal rings, nerve-fibers are given off to the brachia, muscles, and the two lobes of the mantle. It would appear that the nervous system as a whole is more highly developed in the articulate than in the inarticulate brachiopods. It has not been demonstrated that the adult

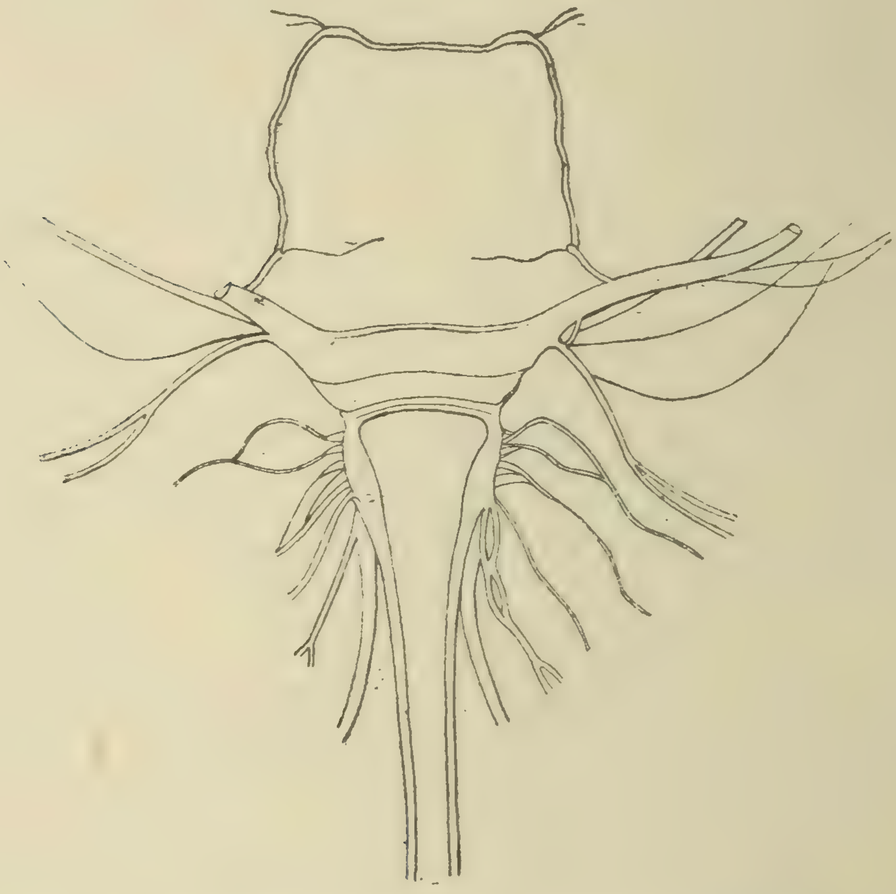

FIG. 188.— Œsophageal ganglion of *Magellania cranium*.
(HANCOCK.)

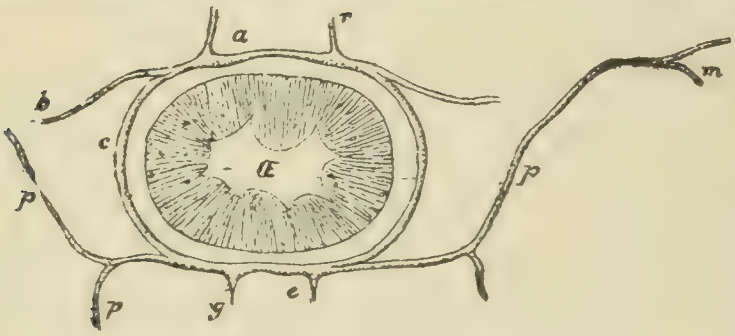

FIG. 189.— Nervous system of *Crania*. Œ, œsophagus in section; *c*, collar; *a*, cerebroid ganglion; *n*, brachial nerve; *e*, subœsophageal ganglion; *g*, inferior nerve; *p*, dorsal pallial nerve; *p*, ventral pallial nerve; *m*, nerve of muscles. (JOUBIN)

brachiopod possesses any *organs of special sense*, but in the embryos of several genera, bodies believed to perform such functions have been observed.

Brooks has shown the existence of an auditory organ in *Lingula*, similar to that of the lamellibranchs, viz.: a pair of otocysts containing vibratile otoliths, which are situated close to the nerve collar.

Similar structures were observed in Discinisca by Müller. The very young of Thecidium, Cistella and Discinisca bear two or four minute pigment spots on the cephalic segment, which are believed to be organs of vision. All trace of these sense organs is resorbed in later growth.

The Reproductive System.

It has already been observed that the brachiopods, so far as known, not only reproduce by ova, but are also diœcious. It is difficult, however, to distinguish the male from the female animal, except upon the approach of fecundity. Then the testes become enlarged by the colorless spermatic fluid, and take on a pale hue; on the other hand, as the ovaries of the female become crowded

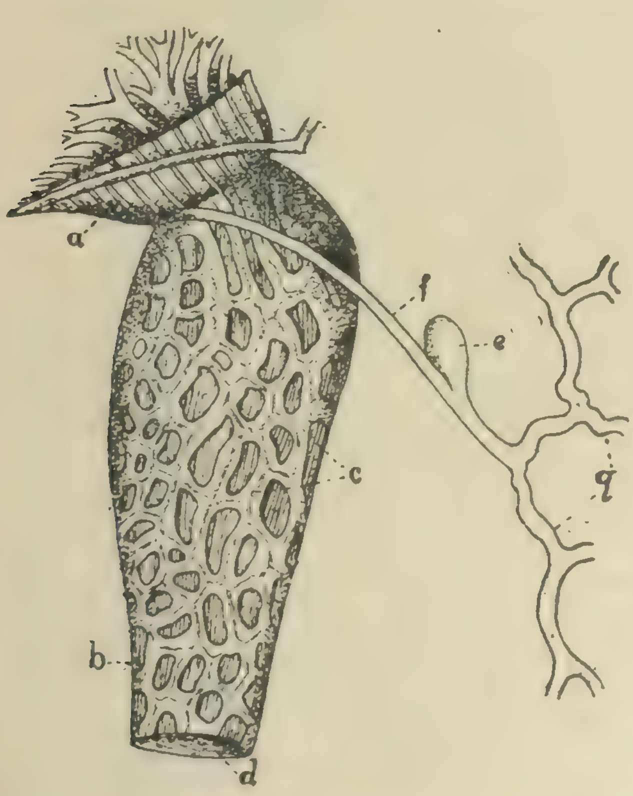

Fig. 190.— Oviduct of *Hemithyris psittacea*, *a*, laminated portion; *b*, tubular portion; *c*, wrinkles of lining membrane; *d*, external opening; *e*, vescicle; *f*, *g*, blood-vessels. (Hancock.)

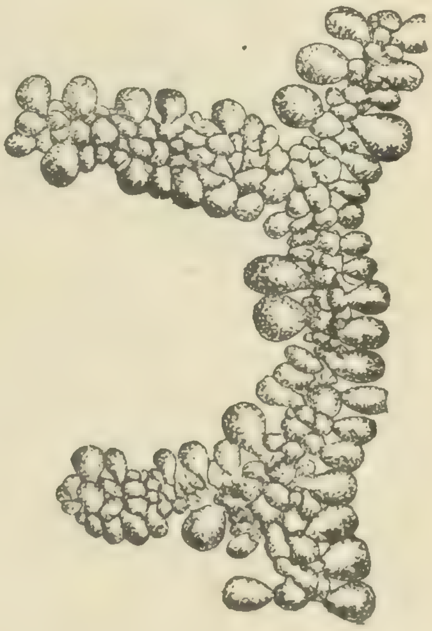

Fig. 191.—Fragment of ovary of Crania. (Joubin.)

with eggs, the slight color of the latter deepens the tint of the entire organ.

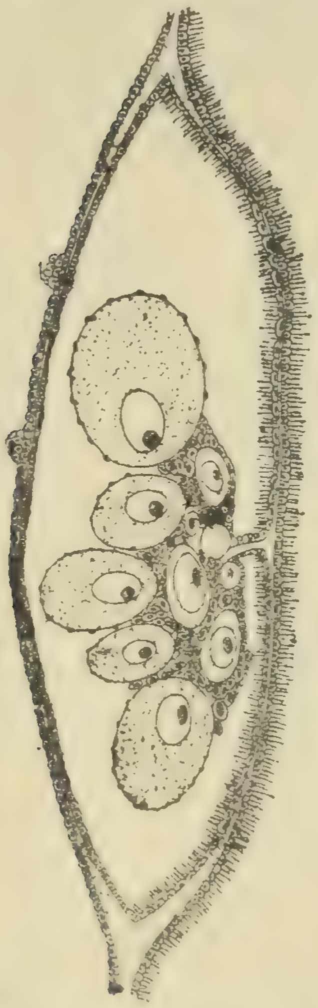

Fig. 192.— Section of ovary of *Crania*, showing the suspended ova in various conditions of development. (Joubin.)

The location of both male and female reproductive glands is essentially the same. Generally they are found to occupy the main trunks of the vascular sinuses though they may extend into the visceral chamber, and, in some of the inarticulate genera (Lingula, Discinisca), be restricted to the latter. When in the pallial sinuses, though attached to the upper and inner wall of the mantle, they frequently leave a lobed or pitted impression upon the shell, which is retained after the shell is fossilized.

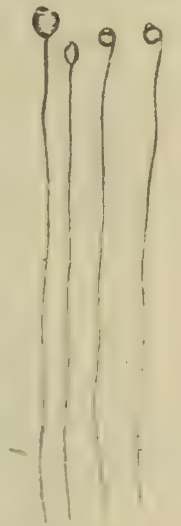

Fig. 193.—Spermatozoids of *Crania* much enlarged. (Joubin.)

The discharge of the genital products is effected by two or four tubular organs or funnels, which have been described by some authors (Owen) as hearts. These trasverse the wall of the perivisceral chamber and open outward into the pallial cavity. Their inner openings are large, expanded orifices, abundantly plaited, and separated by a constriction from the narrower part. Ova have been seen to pass through these organs (Morse) to which they are drawn by the action of the cilia covering their surface. Huxley considers that these funnels also subserve the function of renal organs and that they are homologous to the *organs of Bojanus* in the mollusca, and to the segmental organs of the annelids.

It is generally believed that fecundation takes place after the discharge of the eggs into the pallial chamber or into the sea water. An interesting condition of fecundation occurs in Lacazella and Cistella, which compels the conclusion that the spermatozoids have penetrated from without into the visceral chamber and there fertilized the eggs.

A fold is formed by an expansion of the mantle, which incloses a number of fertilized eggs, attached to two very large brachial cirri, and while in this condition the segmentation of the embryo is effected. It is not known at precisely what stage of development these embryos are set free from the suspensory cirri and emitted into the outer chamber of the valves.

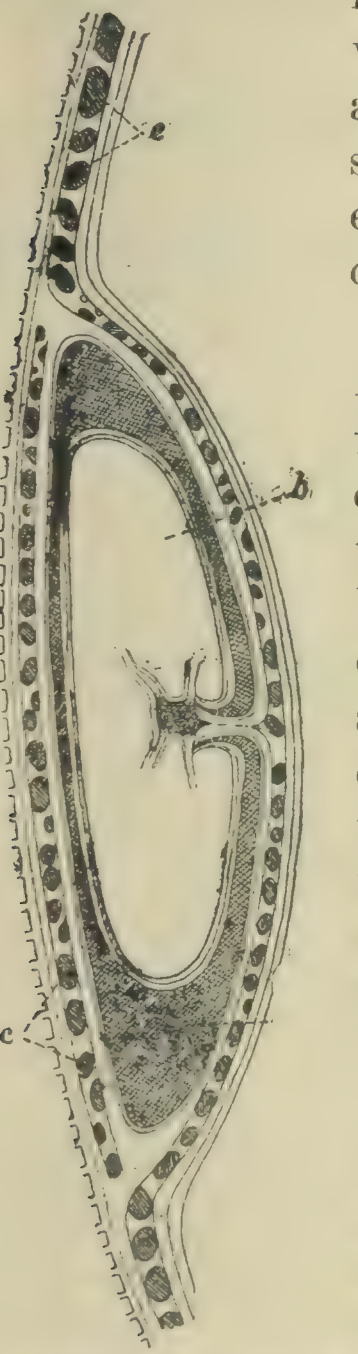

FIG. 194—Transverse section of mantle of *Magellania australis.* *a*, pallial sinus; *b*, genital organ; *c*, pallial lacunes; *d*, bases of pallial caeca. (HANCOCK.)

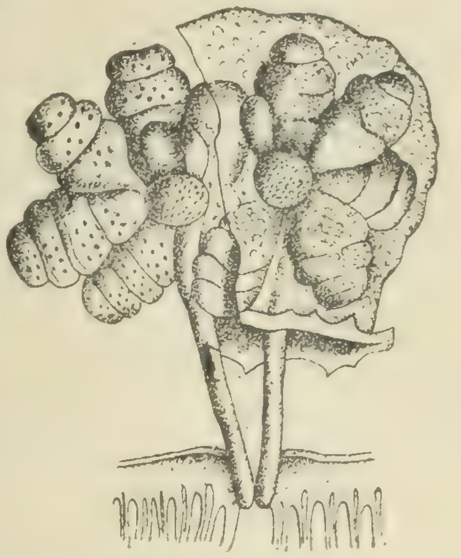

FIG. 195—Embryo-pouch of *Lacazella* partly broken, exposing clusters of segmented embryos attached to the suspensory cilia. (LACAZE-DUTHIERS.)

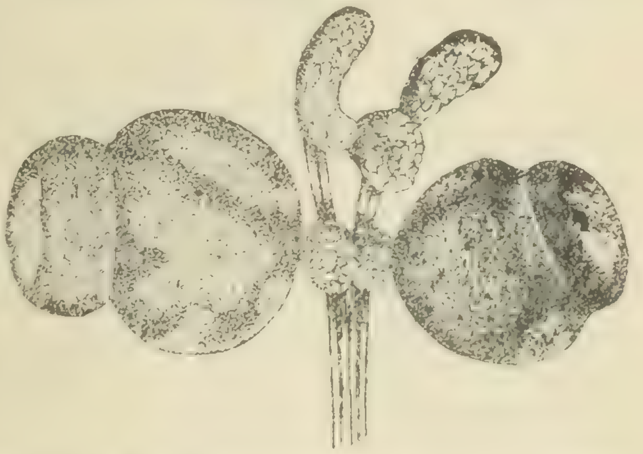

FIG. 196—Two embryos of *Lacazella* attached to the suspensory cilia. (LACAZE-DUTHIERS.)

In a specimen of *Lingula lamellata* from Upper Silurian, of Hamilton, Ontario, the pallial cavity has been found filled with ova; and ŒHLERT cites a specimen of STRINGOCEPHALUS (Middle Devonian) in whose valves were found a number of embryo shells, which would indicate that development had taken place in this chamber. An accelerated growth of the reproductive organs and the perfection of their function is shown in certain species of TEREBRATELLA, which are capable of reproduction during the adolescent *magadiform* and *magaselliform* stages, thus perpetuating a more primitive race which does not attain the characters of the adult TEREBRATELLA.

DEVELOPMENT.*

From the fertilization of the *ovum* to that stage which may be regarded as terminating the embryonic period, the developing brachiopod passes through the conditions of

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* Our knowledge of the embryogeny of the living brachiopods is due to OWEN, HANCOCK, DAVIDSON, MORSE, KOVALEVSKI, LACAZE-DUTHIERS, MÜLLER, SHIPLEY and BROOKS, and is pretty much restricted to the genera TEREBRATULINA, LIOTHYRINA, CISTELLA, LACAZELLA and GLOTTIDIA. The most important contributions upon the morphogeny of the brachiopod shell, are those of C. E. BEECHER.

(1) *Protembryo;* unsegmented and segmented stages, before the formation of a primary internal cavity (blastula or segmentation cavity);

(2) *Mesembryo* or blastophere; a multisegmented body with an internal cavity (blastula cavity);

(3) *Metembryo* or gastrula; a concavo-convex body consisting of two layers formed either by the invagination of the blastula or by the duplication of its cell-layers;

(4) *Neoembryo;* the condition of primary division into a cephalic, caudal, and subsequently a thoracic lobe, with posteriorly directed mantle and bundles of thoracic setæ.

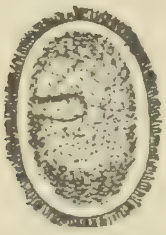


FIG. 197.—*Terebratulina.* First ciliated stage. (MORSE.)

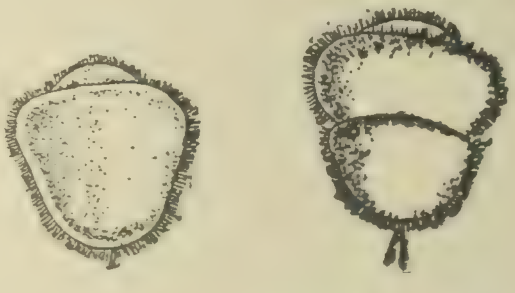


FIG. 198.—*Terebratulina.* Segmented embryos. (MORSE.)

(5) *Typembryo;* in which the mantle lobes have inverted and are folded over the cephalic lobe;

(6) *Phylembryo;* the state in which the characters of the brachiopod-type are defined.

When the egg becomes fertilized it may either remain attached to the mother and pass its early segmented stages in that condition, as in LACAZELLA, or it may be set free into the pallial chamber or into the sea-water. Some such ova develop cilia before segmentation (TEREBRATULINA) and are thus free swimmers; others evidently have no means of locomotion. Where the cilia

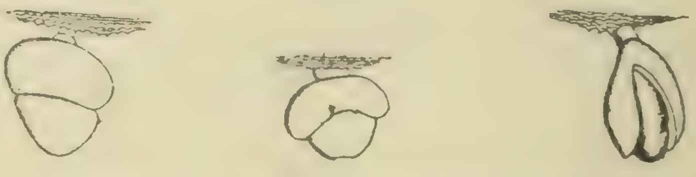


FIG. 199.—*Terebratulina.* Embryos attached by the caudal segment and showing the gradual inclosure of the cephalic segment by the lobes of the mantle. (MORSE.)

are developed in the unsegmented condition they are retained during the blastula and gastrula stages. With the completion of the primary segmentation and the formation of the segmentation cavity or archenteron, follows the division of the embryo into a cephalic and caudal lobe, and the formation of two lateral diverticula from the segmentation cavity. This is the primary *cephalula* stage of the neoembryo, which becomes completed by the development of a third, a median or thoracic lobe, from which four bundles of long setæ are extended posteriorly beyond the caudal lobe (CISTELLA). The cephalic and caudal lobes are cilated but the median lobe is not. At the same time a single pair of pigment-dots or eyes developed on the cephalic segment. In a later condition a second pair of eye spots appears, the thoracic or median lobe becomes elongated and its outer layer (*mantle*) differentiated from the body of the lobe. During this stage the embryo may become attached by its caudal segment or pedicle (TEREBRATULINA). The two divisions or lappets of the mantle, which in the last stage embraced the thoracic lobe are now inverted or revolved upon their basis of attachment, until they gradually inclose the cephalic lobe, and their margins, with the bundles of setæ, are directed anteriorly instead of posteriorly. This initiates the typembryo stage.

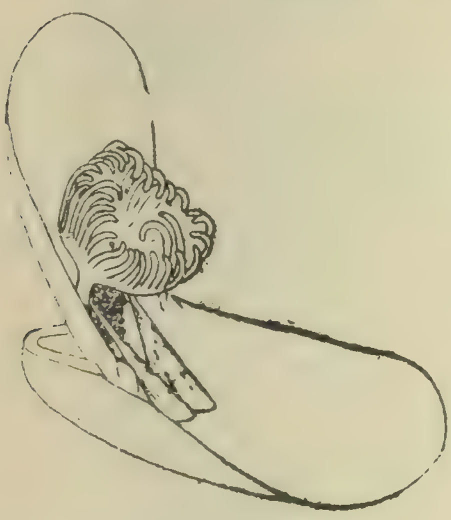


FIG. 200.— *Terebratulina;* a very young shell showing the ciliated arms or lophophore and the diductor muscles. x 20 (MORSE).

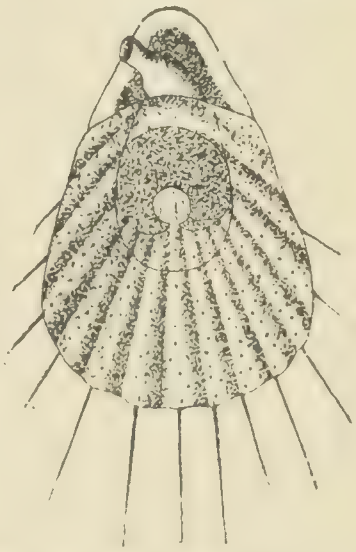


FIG. 201.— *Terebratulina;* a young shell having the punctæ developed. x 20 (MORSE).

At this time CISTELLA becomes attached by its caudal segment though the pedicle in GLOTTIDIA is not as yet developed.

The cephalic lobe now rapidly becomes diminished in size. The digestive tube had already been formed by the tubular enfolding of the walls of this lobe. The muscles in CISTELLA are now in four pairs, two of which extend from the walls of the digestive cavity to the bases of the marginal setæ; these afterward become the *adductor* muscles of the adult animal.

One pair extends to the caudal lobe and becomes the ventral *pedicle-muscles.* The fourth pair extends from the dorsal to the ventral wall of the body, just behind the digestive cavity; this becomes the *diductor* muscles. There is a fifth pair of dorsal pedicle-muscles in LIOTHYRINA.

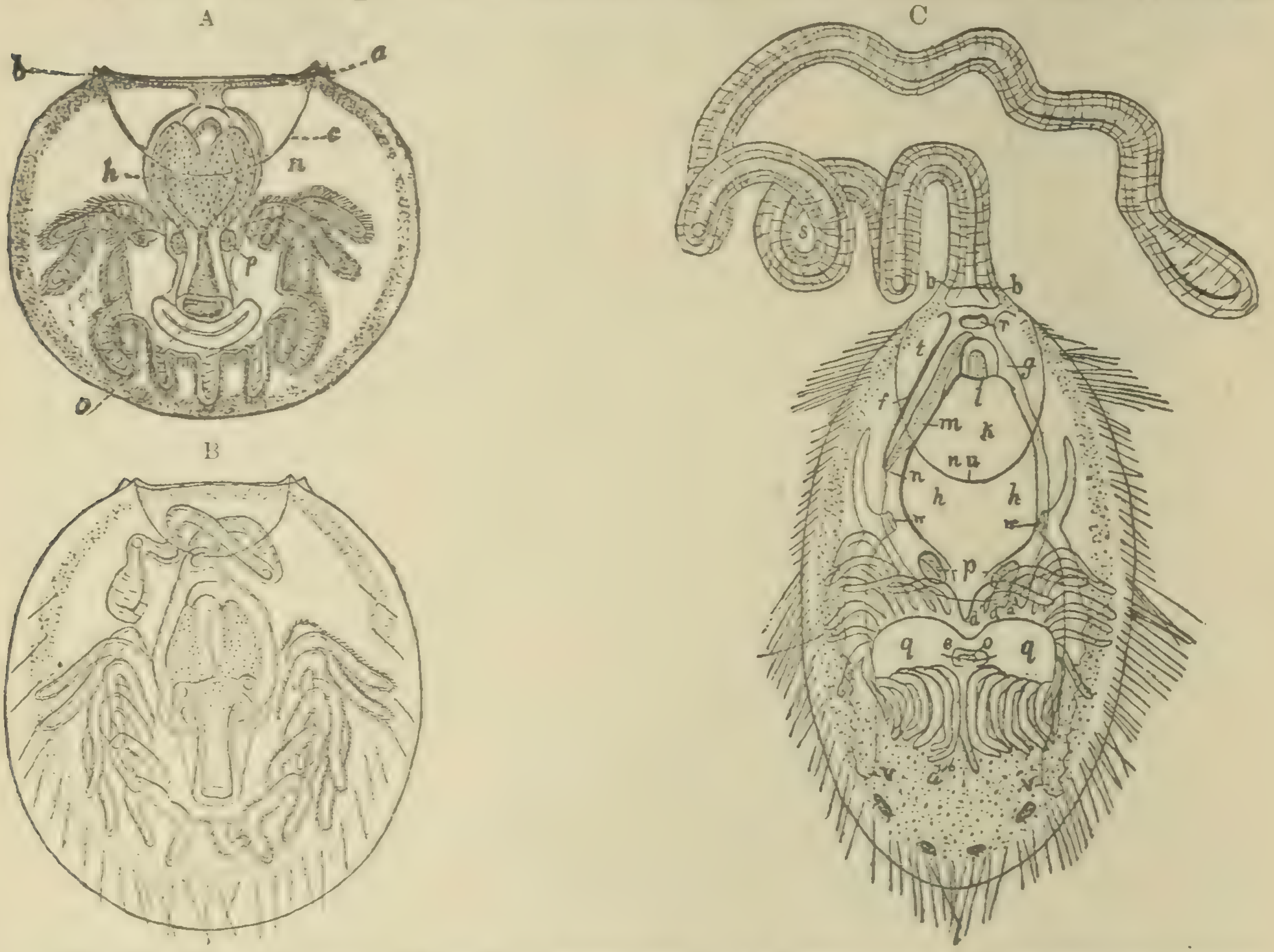


FIG. 202 — Embryonic stages of *Glottidia Audebarti.* A. Dorsal view of the youngest embryo observed; B. Dorsal view of a somewhat older embryo; C. Ventral view of an individual soon after becoming sedentary; *a*, hinge-teeth of brachial valve; *b*, hinge-teeth of pedicle-valve; *c*, semicircular plate of brachial valve; *d*, median tentacle; *f*, parietal bands; *g*, body cavity; *h*, liver; *k*, hepatic chamber of stomach; *l*, intestinal chamber of stomach; *m*, intestine; *n*, anus; *o*, mouth; *p*, muscles; *q*, lophophore; *r*, posterior unpaired muscle; *s*, pedicle; *v*, pallial sinus; *w*, its opening into the body cavity; *nu*, edge of larval shell. (BROOKS.)

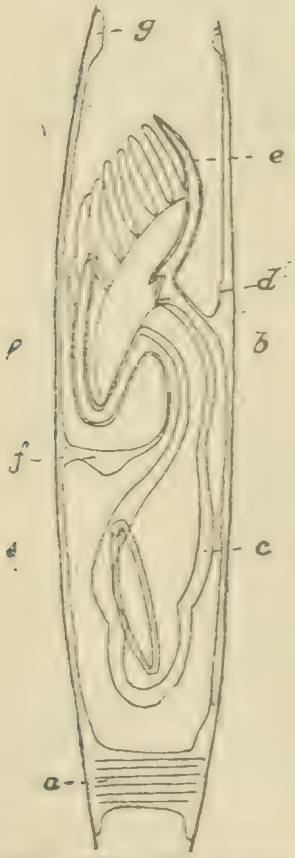


FIG. 203 — Diagrammatic longitudinal section of young of *Glottidia*. *p*, pedicle-valve; *b*, brachial valve; *a*, umbonal muscle; *c*, stomach; *d*, mouth; *e*, lophophore; *f*, ganglion; *g*, border of mantle.—(BROOKS.)

Following this condition the four bundles of setæ are lost, the eye spots disappear, the digestive tube and stomach become well defined, the cilia of the brachia or lophophore appear, and the valves of the shell, which before had been simple plates upon the surface of the mantle lobes, come into contact about their lateral and anterior margins. The animal has now taken on the appearance of a brachiopod and is a phylembryo. Later growth to the adult condition consists in the perfecting of the details now outlined in the embryo.

The Development of the Shell.

There are at least two types of shell development among the articulate brachiopods. One of these is exemplified by Thecidium, which has been shown by Beecher to be a living representative of the extinct palæozoic group provided with a deltidium formed of a single plate or sheath; like Strophomena and its allies. (Plate 16, Figs. 1-18.) The other is represented by Cistella, which typifies the group bearing discrete deltidial plates. In both of these, the first traces of the shell are found in the neoembryo. In the cephalula stage of *Thecidium* (*Lacazella*) *mediterraneum* the dorsal lobe of the mantle develops more rapidly than the ventral, and its inner surface bears a flat shell-plate. A similar plate is

Fig. 204.

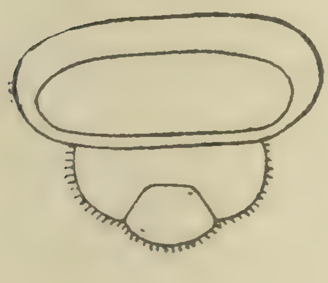


Fig. 206.

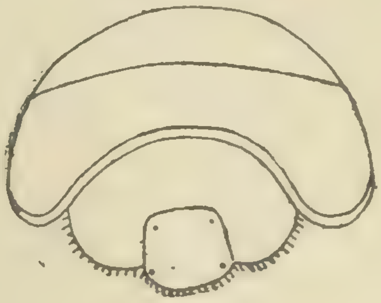


Fig. 209.

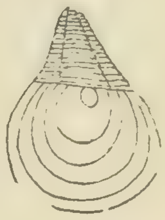


Fig. 205.

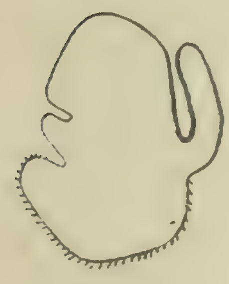


Fig. 207.

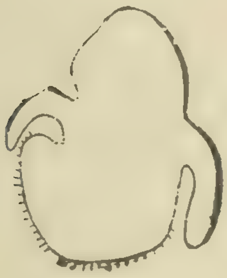


Fig. 208.

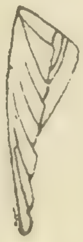
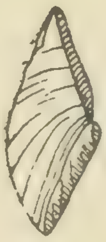


Fig. 210.



Thecidium (Lacazella) mediterraneum.

Fig. 204.—Cephalula, dorsal side; showing below, the cephalic segment with eye-spots, and on the upper segment the dorsal shell-plate.

Fig. 205.—Dorso-ventral longitudinal section of cephalula; below is the cephalic segment, at the right the dorsal mantle lobe, the thickened line on its inner margin representing the beginning of the dorsal valve, and the similar line on the adjoining side of the body the incipient deltidium.

Fig. 206.—A later growth stage (typembryo), in which the mantle lobes have turned downward. The body shell plate is seen in theupper part of the figure.

Fig. 207.—Dorso-ventral longitudinal section of the preceding; showing the inversion of both mantle lobes. The relations of the dorsal and body (deltidium) plates are shown by the heavy lines at the right. The ventral plate is also seen on the lobe at the left.

Fig. 208.—Profile of a very young specimen of *Leptæna rhomboidalis* oriented to correspond with the foregoing figures.

Figs. 209, 210.—Views of adult *Thecidium (Lacazella) mediterraneum* similarly placed. (Beecher; figs. 204-207, adapted from Kovalevski.)

developed on the body of the thoracic lobe covered by this portion of the mantle. Subsequently, during the neoembryonic period, a shell-plate is also formed on the inner surface of the ventral lobe of the mantle. By the inversion of the mantle-lobes, these plates formed on their inner surfaces, become external and inclose the cephalic lobe. Their attached or inner edges, though separated by the entire width of the thoracic segment, make the hinge-line. The body-plate is now in contact with the dorsal-plate or valve at its inner edge, but does not touch the ventral valve, the two latter being separated by the width of the caudal lobe or pedicle. This body-plate, or third valve, is the incipient *deltidium*. Subsequently, by lateral extension, the dorsal and ventral valves come into contact at their cardinal

Fig. 211.

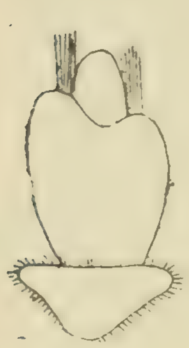


Fig. 213.

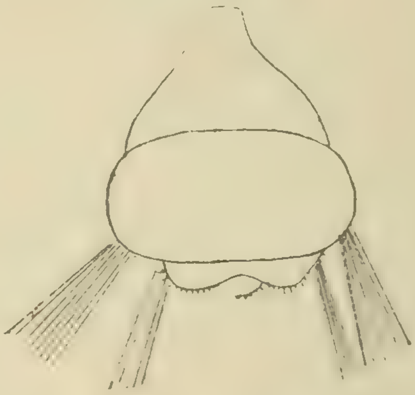


Fig. 215.

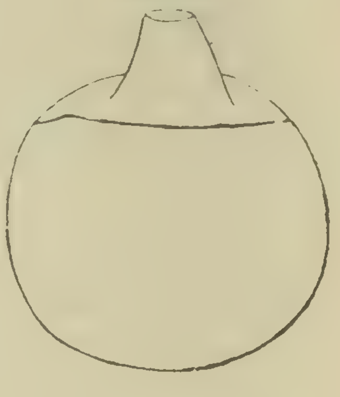


Fig. 212.

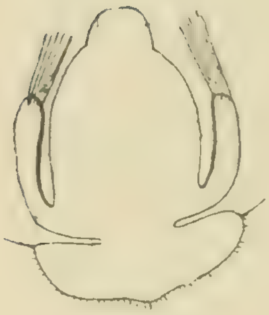


Fig. 214.

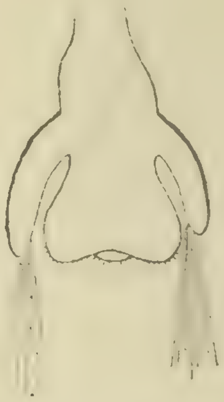
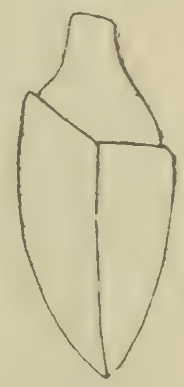


Fig. 216.



Cistella neapolitana.

Fig. 211.— The completed cephalula stage: the ventral and dorsal mantle lobes are at the right and left respectively.

Fig. 212.— Longitudinal section of the same; the shell secreting surfaces are represented by heavy lines.

Fig. 213.— Typembryo; the larva after the inversion of the mantle lobes.

Fig. 214.— Longitudinal section based on the preceding. The shell bearing surface of the mantle lobes are now on the outside of the animal, the large pedicle extending downward.

Figs. 215 and 216.— Dorsal and profile views of a very young shell; showing the large posterior opening between the valves and the thick pedicle. (Beecher. adapted from Kovalevski and Shipley.)

extremities; the ventral valve meets the deltidium and becomes anchylosed with it, leaving an opening for the passage of the pedicle. The union of the three shell-plates in the phylembryo forms the completed embryonic shell or *protegulum.*

In CISTELLA, and presumably in all articulate brachiopods possessing deltidial plates, the mode of development of the shell is quite different. The ventral lobe of the mantle is here the longer, and no body-plate is formed on either side of the thoracic lobe. When, therefore, the mantle lobes are reversed and the valves come into contact about their peripheries and at the cardinal extremities, the caudal lobe, or pedicle, occupies all the space between the posterior margins of the valves. The large,

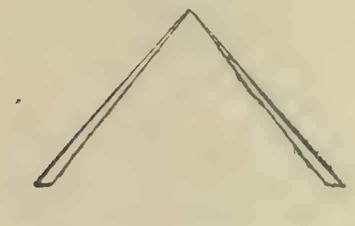


FIG. 217.— Dethyrium of a young *Rhynchonella* without deltidial plates.

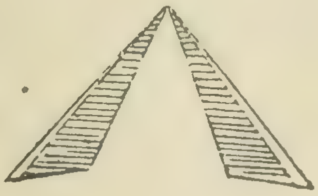


FIG. 218.— The same at a later stage with two triangular deltidial plates.

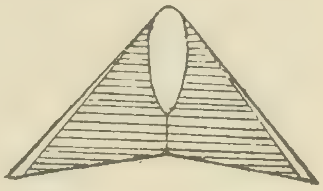
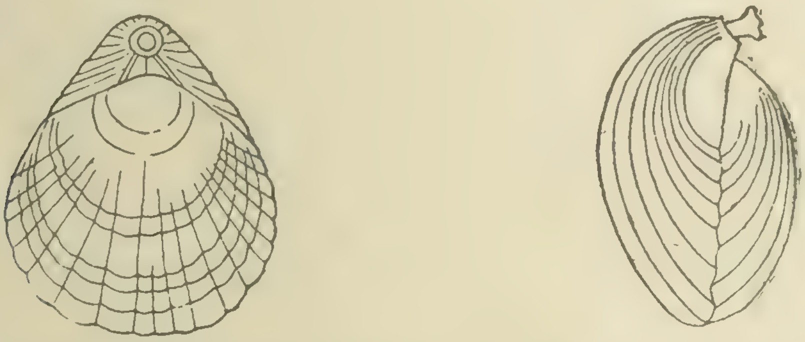


FIG. 219.— The same at completed growth of the deltidial plates.



FIGS. 220 and 221.— Dorsal and profile views of *Magellania flavescens*, showing deltidial plates and pedicle.

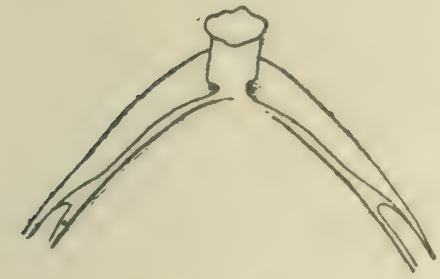


FIG. 222.— Dorsal view of the umbonal portion of an adult *Terebratulina septentrionalis* with the shell removed by acid; showing slight secondary extensions of the central mantle around the pedicle, small deltidial plates only, being secreted in this species.

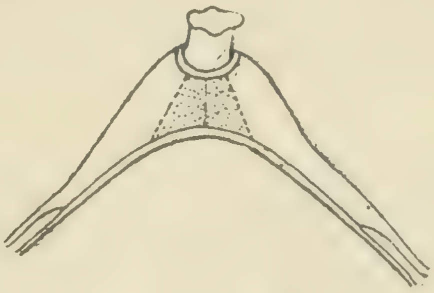


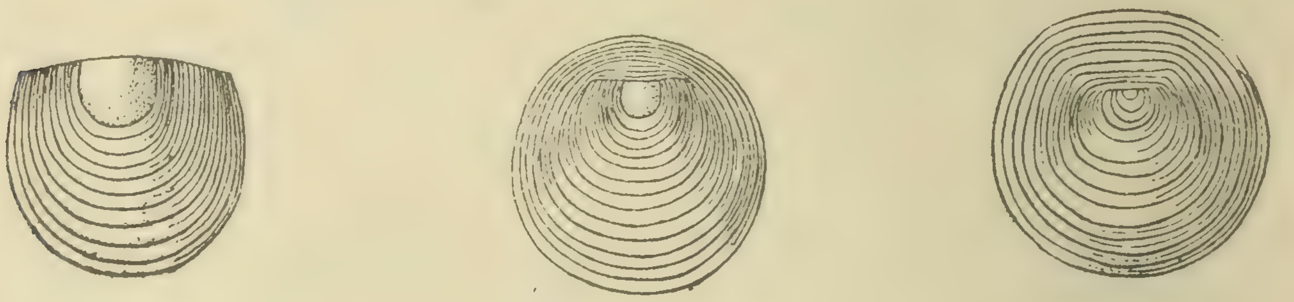
FIG. 223.— Similar preparation of *Magellania flavescens;* showing the complete envelopment of the base of the pedicle by secondary expansions of the ventral mantle which have formed the deltidial plates, as shown in fig. 220. (After BEECHER.)

triangular, unclosed fissure thus formed, persists throughout early post-embryonic growth-stages. It has already been observed that the period at which deltidial plates begin to appear, and the degree of development which they attain in this group, varies with the species. Thus in most forms of RHYNCHOSPIRA and in *Meristina Maria* they are completed at an early adolescent stage, while in *Meristina rectirostra*, they are in a primary condition of development at maturity, and the pedicle is at no time restricted to a foramen.

In MAGELLANIA when the deltidial plates begin to develop, it has been found that they are secreted by secondary extensions of the ventral mantle from along the margins of the deltidium, these laminar processes beginning at the cardinal margin and meeting though not uniting along an axial line. (BEECHER.)

It is therefore to be concluded that the deltidial plates are of post-embryonic or secondary growth and that the absence of the body-plate or deltidium in the embryo of CISTELLA is to be regarded as an instance of acceleration of development in which this primary phase has been omitted.

There is a difference in the intimate structure of the deltidium and deltidial plates, in punctate shells; the former being developed from the body of the thoracic lobe and not from the mantle, and has no punctæ; the latter, originating from the mantle, are perforated by its cæcal extensions.



Orbiculoidea minuta,

Three growth stages; showing the change from the paterina-stage with transverse cardinal margin, to the circular outline of the adult. Fig. 224 x 36; fig. 225 x 16; fig. 226 x 10; figs. 224 and 225 show the form of the protoconch. (BEECHER.)

In many of the brachiopoda the *protegulum* or embryo shell is retained throughout later growth stages. This is true where the apices of the valves have not become greatly modified by the encroachment of the pedicle. Its valves are subsemicircular and smooth, the hinge-line straight and its general form exemplified in the adult condition of the primordial genus PATERINA.

Post-embryonic Stages.

With the completion of the protegulum and the incipient development of the lophophore, the embryonic condition of brachiopod may be regarded as closed. The subsequent periods in the life of the animal may be divided into (*a*) the infantile; (*b*) the adolescent; (*c*) the adult; (*d*) the senile.

During the infantile condition, additions made to the protegulum usually modified the outline of the shell, and bear only the concentric lines upon the surface. The cæcal perforations of the shell appear at this period (Terebratulina). The animal is usually attached by its pedicle, but in Glottidia this organ is not yet protruded from between the valves. In the adolescent period the shell takes on the normal outline of the species, and surface plications and other external ornament and configuration now make their appearance. The lobes of the lophophore become developed, the digestive tract extended and completed, and, in Glottidia, the pedicle is protruded and highly developed. After passing the period of maturity, the senile shell undergoes various changes. Callosities and deposits of adventitious calcareous matter are formed about the internal processes; the valves are thickened instead of being increased in diameter, the characteristic ornamentation of the shell may be temporarily or permanently lost, and the surface become smooth. * Growth in this period of decline is reversional, manifesting a resumption of infantile characters. Hyatt has defined two stages of senile growth; one preliminary or progressional, that in which the characters of maturity are disappearing in the reverse order of their appearance; the other, extreme or final, when the shell has finally reverted to its own condition during the infantile period.

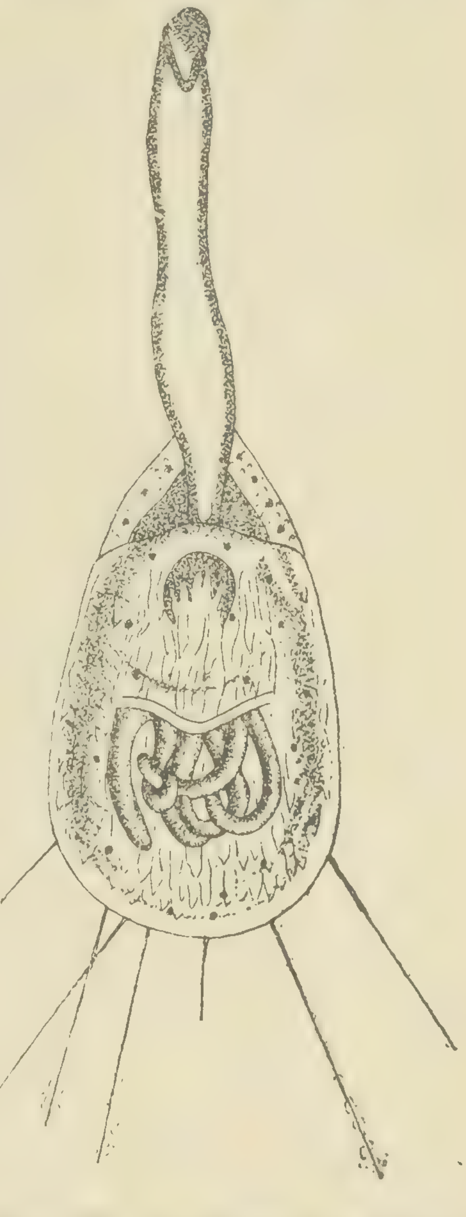


Fig. 227.—*Terebratulina*. A very young shell, with pedicle, cilia, setæ and punctæ developed. (x 300) (Morse).

A chapter on Classification will follow the discussions of the genera.

THE GENERA OF THE BRACHIOPODA.

I.

BRACHIOPODA INARTICULATA.

Valves inarticulated; intestine terminating in an anus on one side of the body; shell substance largely phosphatic.

The foregoing characters bring into association a well defined assemblage of these organisms, but, while generally applicable throughout the group in expressing the fundamental distinctions from the more abundantly developed Brachiopoda Articulata, there often appear, in forms which can not be separated from such association, tendencies to transgress these limitations in various directions. For example, articulation of the valves was approached, if not effected, in the linguloid Barroisella, in Spondylobolus, and, perhaps also, in Neobolus and Trimerella. In Crania, according to the determination of Joubin, the anus opens in the median line of the body; and in various genera, Crania, Pholidops, Trimerella, etc., there is evidence that the substance of the shell was essentially, or altogether calcareous.

For this division of the Brachiopoda it seems preferable to adopt Professor Huxley's term, Inarticulata, as having the advantage of euphony and simplicity. Other writers have made use of terms with different significations, all having precisely the same scope. Professor Owen, in 1858, proposed the term Lyopomata (λύω and πῶμα), essentially the Greek equivalent of Inarticulata, and of Bronn's Ecardines. The last named author also suggested the term Pleuropygia, derived from the lateral position of the intestinal perforation; while King's term, Tretenterata, indicates that the existence of an anus is to be regarded as the essential character.

Lingula, Bruguière. 1789.

(Plate 1, Figs. 1–9).

Shells sub-equivalve; elongate-ovate, sub-quadrate or sub-triangular in outline; broad over the pallial region, cardinal slopes more or less conspicuous; slightly gaping at both extremities. Brachial valve somewhat the shorter, and with a slightly thickened hinge-line. Surface of the shell smooth, or concentrically and radiately striated. Animal attached by a long, muscular pedicle protruding from between the beaks of the two valves. The pedicle-valve has a distinct cardinal shelf or area, divided longitudinally by a depression widening from the apex anteriorly, and termed by KING the "deltidium." This, according to Professor KING, is usually not well developed, and in the average specimens of *L. anatina* found in museum collections, appears to be partially or quite wanting, from accidental causes. The deltidium is bounded at the sides by elevated ridges, which, at the anterior ends, are each developed into a small callosity.

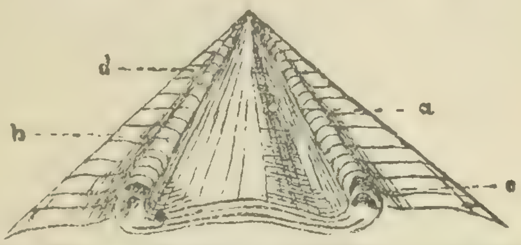


FIG. 228.—*Lingula anatina*; cardinal area of pedicle-valve, after KING. *a*, deltidium; *b*, deltidial ridges; *c*, deltidial callosities; *d*, areal borders.

Muscular impressions numerous, but usually indistinct. In the recent species they are twelve in number upon each valve, and are somewhat unsymmetrical in their arrangement. They may be designated as follows: The *umbonal* impressions (*g*), produced by a single muscular band passing directly across the cavity of the shell near the beaks, and by their contraction opening the valves; the *lateral* impressions, which are produced by three pairs of muscles, the *anteriors* (*j*) passing from near the lateral boundaries of the visceral area on the pedicle-valve, forward to the anterior extremity of this tract on the brachial valve; the *middles* (*k*) passing in just the opposite direction, from the anterior region of the pedicle-valve to the lateral region of the brachial valve; the *externals* (*l*) passing from the ante-lateral region of the pedicle-valve to the post-lateral region of the brachial valve, these muscles serving to move the valves forward and backward. The *central* impressions (*h*) are

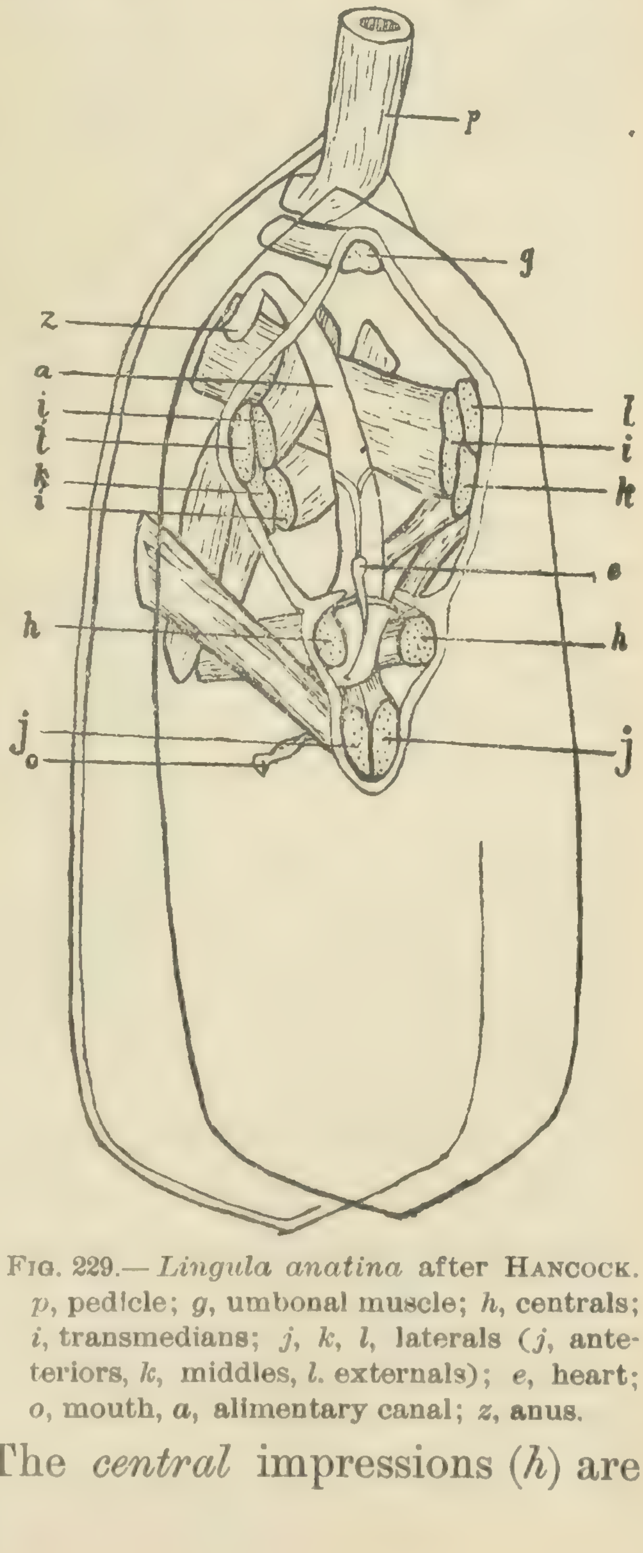


FIG. 229.—*Lingula anatina* after HANCOCK. *p*, pedicle; *g*, umbonal muscle; *h*, centrals; *i*, transmedians; *j*, *k*, *l*, laterals (*j*, anteteriors, *k*, middles, *l*. externals); *e*, heart; *o*, mouth, *a*, alimentary canal; *z*, anus.

produced by a single pair of muscles extending across the antelateral region of the visceral area, and by the contraction of these, the valves are closed. The *transmedian* impressions (*i*), are made by a triple muscle, one band of which is on one side the visceral area, the other two on the other side, the two lateral components crossing each other in passing from the posterior region of the pedicle-valve to the medio-lateral region of the opposite valve. By the action of these muscles the animal is able to slide apart, laterally, the anterior and posterior extremities of its valves. The muscular region in each valve is surrounded by the *parietal* bands (*b*), which leave more or less distinct impressions upon the shell

The anterior internal surface of each valve bears traces of two strong pallial sinuses, which nearly meet in the axial line before reaching the anterior margin. In front of, and behind these are to be seen radiating vascular markings.

Shell substance composed of alternating lamellæ of chitinous and calcareous material.

Type, *Lingula anatina*, Lamarck.

Distribution. (Cambrian?) Lower Silurian — Recent (China, Japan, Guinea, Australia, Philippines, Sandwich Islands.) The genus attained its culmination in the Silurian and Devonian, about seventy species being known from the former on the North American continent.

Remarks. There are at present no satisfactory means of separating generically, from the type of the genus, the great majority of fossils passing under the name of Lingula. Internal casts bearing muscular and pallial impressions quite similar to those of recent species have been found in rocks as old as the Lower Silurian (Trenton), and whenever traces of such internal markings are preserved, there seems to be little difficulty in reconciling them with those of the living shells. Favorably preserved examples from the Carboniferous have shown even the unsymmetrical scars of the lateral or sliding muscles. In many of the extinct forms it is evident that the scars were deeper and the shells thicker and more calcareous than in the species now extant.

The retention of the pedicle in the fossil state has been observed in some Silurian and Carboniferous species.

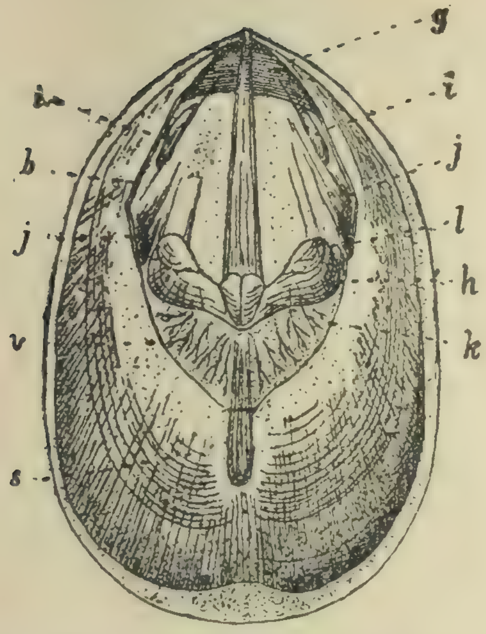


FIG. 230.—*Lingula paracletus*, HALL. Interior of pedicle-valve.

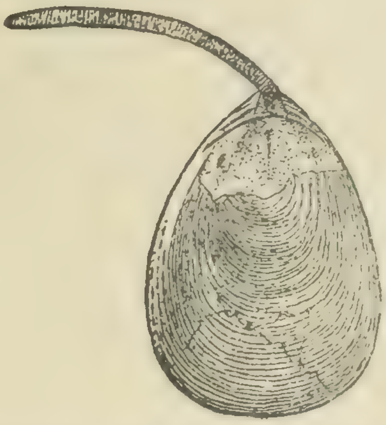
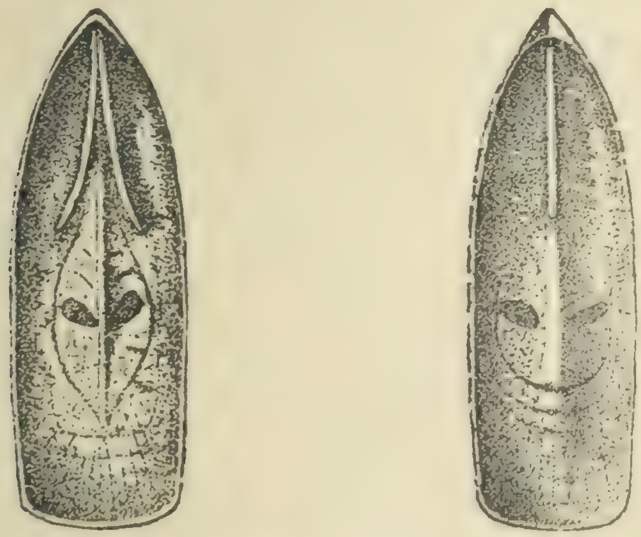


FIG. 231.—*Lingula ? Leseuri* Ronault; with pedicle. (DAVIDSON.)

Subgenus **Glottidia**, Dall. 1870.

Animal free, and forming a tube or capsule about the pedicle by the agglutination of sand grains, etc.; pedicle highly contractile. Interior of pedicle-valve with two septal ridges diverging from the beak; brachial valve with a single median ridge.

Type, *G. albida*, Hinds (sp.)



Glottidia Palmeri.

FIG. 232.—Interior of pedicle-valve.

FIG. 233.—Interior of brachial valve. (DAVIDSON.)

Distribution. (Fossil ?) Recent (California, the Carolinas). This subgenus is regarded by Dall as the representative of LINGULA in American seas.

Subgenus **Dignomia**, Hall. 1871.

(Plate 1, figs. 12, 13.)

Shells with broad, flat median ridge and lateral, sub-marginal parietal grooves in the pedicle-valve, a more conspicuous median ridge in the brachial valve, with submarginal, diverging ridges corresponding to the grooves of the opposite valve.

Type, *Dignomia alveata*, Hall. Hamilton group (Devonian).

Subgenus **Glossina**, Phillips. 1848.

(Plate 1, figs. 10, 11.)

Outlines subtrigonal; beaks acuminate. Internal markings obscure.

Type, *Glossina attenuata*, Sowerby (Sp.).

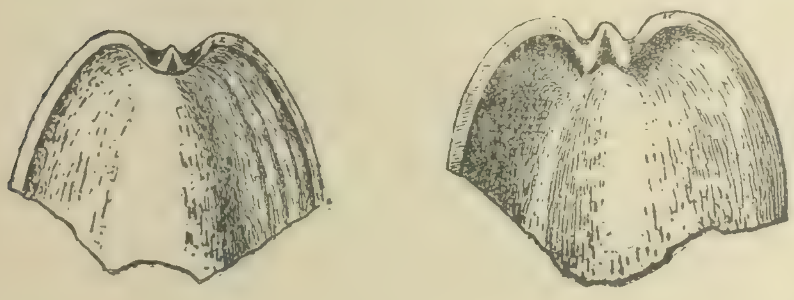
Distribution. Lower Silurian—Devonian (?).

Barroisella, Hall. 1892.

(Plate 1, figs. 14, 15.)

Shell externally as in Lingula. The pedicle-valve bears a high cardinal area, which is a thickened triangular plate divided by a broad pedicle-groove. On the basal margin of the cardinal area, at the angles made by the lateral margins of the pedicle-groove, is a pair of bosses or condyles, which have served either as muscular fulcra, or, to some extent, as points of articulation with the opposite valve. The interior of the pedicle-valve bears a subquadrate depressed area lying directly beneath, and almost in continuation of the pedicle-groove; this may represent the umbonal muscular scar. From its ante-lateral angles diverge two sharply defined, linear depressions, which extend about one-fourth the length of the shell, and end abruptly. From outside and behind the extremities of these depressions, begins a pair of long, curved furrows, composed of two shorter curves, the posterior rounding over the extremities of the linear depressions referred to, the anterior and longer curves gradually approximating and nearly meeting at a point about one-third the shell's length from the anterior margin. These furrows are accompanied by low ridges along their inner margin. A low median ridge, with elevated edges, begins at the posterior umbonal impression, and continues to the center of the valve, widening near its anterior extremity. Just behind its termination is a pair of small, usually indistinct muscular impressions, probably the scars of the central muscles.

In the brachial valve the beak is scarcely prominent, and the muscular markings are essentially as in the opposite valve, but more sharply developed. Beneath the beak is a faint umbonal scar, the lines diverging from which are discernible. The long compound lateral curves have a considerably greater degree of curvature than in the pedicle-valve, their posterior portion inclosing a thickened area, which is continued into a peculiar low and thickened median septum, bifurcating in the middle of the valve, the angle being occupied by an intercalated ridge, which extends for twice the length of the branches of the septum. The central scars are situated further backward at the junction of the median septum with the posterior thickened area.


Figs. 234, 235.—*Lingula Criei.* **Internal cast and interior of posterior portion of pedicle-valve. (Davidson.)**

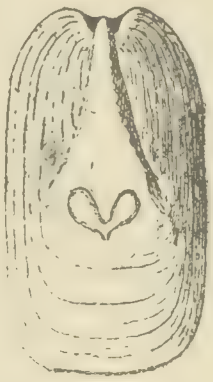


Fig. 236.—*Lingula Criei.* **Internal cast of pedicle-valve. Natural size. (Davidson.)**

Type, *Barroisella subspatulata*, Meek and Worthen (sp.). Genesee slate (Devonian).

Distribution. Silurian—Devonian.

Subgenus **Tomasina**, Hall. 1892.

Externally like Lingula. The pedicle-valve is very slightly convex, its posterior margin being notched. This notch is divided medially by a small triangular elevation at the base of which, on the inner margin of the valve, are two conspicuous articulating (?) processes.

Type, *Tomasina Criei*, Davidson (sp.). Silurian.

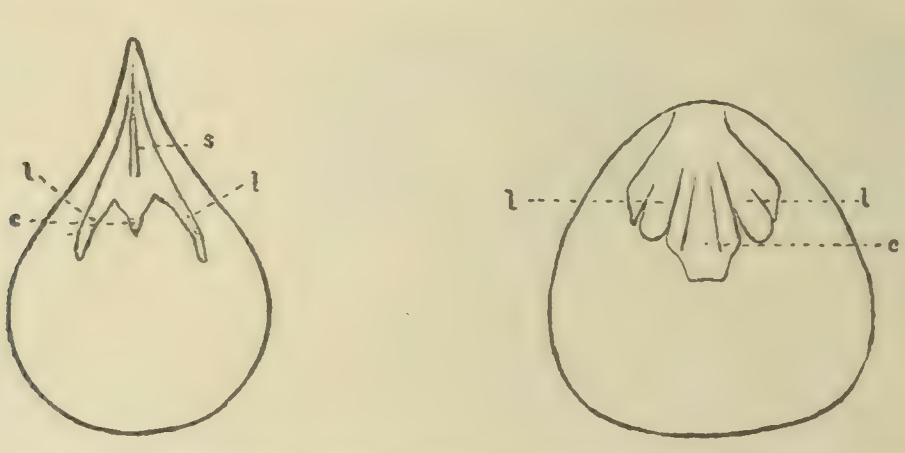
Lingulepis, Hall. 1863.

(Plate 1, figs. 16, 17.)

Shells linguloid; pedicle-valve attenuate and produced at the beak; brachial valve obtusely ovate.

On the interior the pedicle-valve bears a single large scar, occupying the entire umbonal region, which is produced anteriorly into two narrow lateral branches, extending for about one-half the length of the shell. Between them and continuous with their posterior portion, lies a central scar, not extending so far forward, but together with the lateral branches giving the entire muscular impression a strongly tripartite character. There is a low median ridge, elevated along its margins, depressed in the middle; similar to but fainter than in *Lingula anatina.*

In the brachial valve the muscular impressions make a conspicuous flabelliform scar, extending medially about one-half the length of the shell. The central portion of this scar is accompanied on either side by broader, partially resolvable lateral scars, all the subdivisions of the impression coalescing in the unbonal region. There is no septum in this valve.



FIGS. 237, 238.—*Lingulepis pinniformis.* *l*, lateral scars; *c*. central scars; *s*, septum.

Type, *Lingulepis pinniformis*, Owen (sp.).

Distribution. Cambrian. About six species are known in American faunas.

Lingulella, Salter. 1866.

(Plate 3, Figs. 1–4.)

Shells linguloid externally. The passage for the pedicle is a sharply defined slit, not merely making a depression upon the surface of the cardinal area but apparently penetrating it from apex to cardinal line. In the interior the pedicle-valve bears two ong, narrow crescentic lateral scars, and shorter, more or less coalesced central scars, somewhat tripartite in outline.

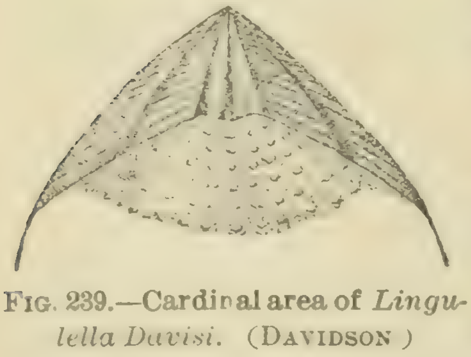
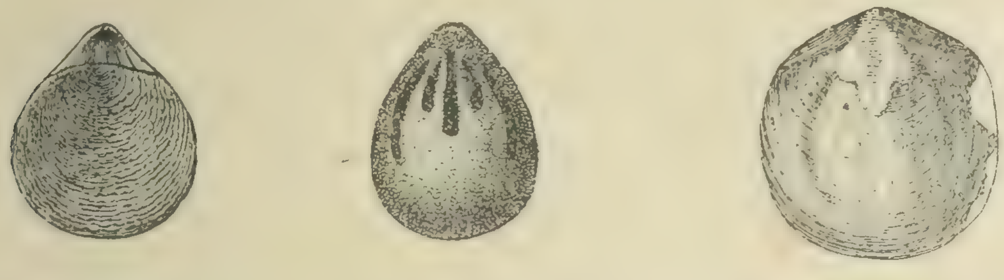


FIG. 239.—Cardinal area of *Lingulella Davisi.* (DAVIDSON.)

In the brachial valve are two diverging lateral scars, extending about one-half the length of the shell, and incurving at their anterior ends toward the more conspicuous, and apparently compound central scar.

Type, *Lingulella Davisi*, McCoy (sp.).



Lingulella Ella, Hall and Whitfield. FIG. 240.—Dorsal aspect, showing pedicle-area. FIG. 241.—Internal cast of pedicle-valve. FIG. 242.—Internal cast of brachial valve. (WALCOTT.)

Distribution. Cambrian — (?) Lower Silurian.

It is possible that the Devonian (Hamilton) species *Lingula paliformis*, Hall, belongs to this genus.

Lingulops, Hall. 1871.

(Plate 1, Figs. 18–20.)

Shells small, linguloid; both valves with a relatively broad cardinal area, which is divided transversely into two parts, (*a*) a smooth, narrow, apical portion; (*b*) a broad inner band, along which the valves appear to have been in contact. This band is flattened and projects into the interior cavity of the shell, like a narrow lunate shelf; on the pedicle-valve it is concentrically striated or smooth, and gently convex. The pedicle-groove crosses this inner area only, not encroaching on the apical area of either valve. Directly in front of the cardinal area, is a narrow crescentic ridge, the anterior margin of which is deeply excavated. This ridge, which is parallel and co-extensive with the cardinal area, bears a median angulation, projecting backward toward the pedicle-groove.

In the interior of the pedicle-valve is an elongate median muscular scar accompanied by two pairs of lateral scars. The median portion of the muscular area is thickened, forming an incipient platform, from the anterior edge of which extends a median septum. The posterior margin of the muscular area bears a trilobed parietal scar.

The interior of the brachial valve shows the cardinal area, pedicle-groove and the crescentic ridges essentially as on the opposite valve. The muscular scallops are represented by three depressions, closer together than in the other valve. The platform is here more highly developed and shows on its surface indications of the median and lateral muscular scars. No median septum is present in this valve.

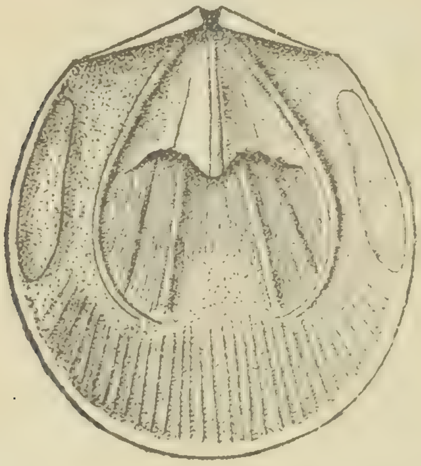
Type, *Lingulops Whitfieldi*, Hall.

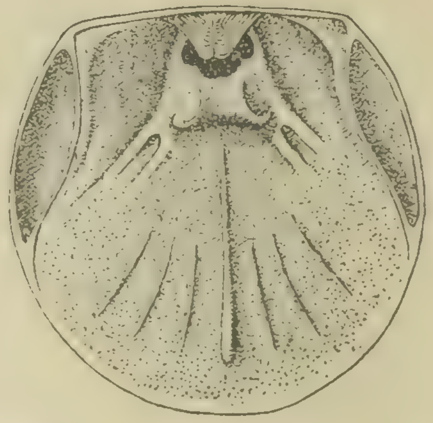
Distribution. Silurian (Hudson River — Niagara groups). Four species are known in North and South American faunas.

Lakhmina, Œhlert. 1887.

Synonym ; *Davidsonella*, Waagen.

General outline more or less linguloid. The pedicle-valve is the larger and possesses a prominent apex, which is provided, on its lower surface, with a deep furrow for the pedicle. In the interior of the pedicle-valve, the cardinal margin is somewhat thickened, without forming a distinct area. Below this is a not very large triangular vaulted platform, supported by a median partition not extending beyond its anterior margin. This platform is inclosed by low, rounded ridges which originate near the pedicle-furrow; its surface is flattened medially, but concave on the sides. Of muscular impressions nothing has been observed. In the dorsal valve the cardinal margin is but little thickened and slightly curved. In the middle it bears a thickened process, which is directed somewhat upward and inward, extending partly into the apical cavity of the other valve. From beneath this process, a short thickened platform takes its origin; it is not even on the upper surface, but to all appearances spirally





Lakhmina linguloides, after Waagen.

Fig. 243.— Pedicle-valve,

Fig. 244.— Brachial valve.

rolled; it is concave in the middle and bears on both sides elevated crests with sloping lateral faces; its anterior margin is curved inward, and the whole platform seems to be excavated below. From its sides diverge two bifurcating ridges, and a median septum extends nearly to the anterior margin. Near the lateral margins two sharply defined spaces are inclosed by narrow ridges. The interiors of both valves are marked with radiating striæ. Shells small; shell substance very thin.

Type, *Lakhmina linguloides*, Waagen (sp.). Obolus-beds of India (Cambrian). But one species is known.

Lingulasma, Ulrich. 1889.

(Plate 1, Figs. 21–24.)

Shells large, sub-quadrate, linguliform, sub-equivalve; the brachial valve considerably the deeper. Beaks apical, cardinal margins gently sloping to the sides. External surface covered with concentric or radiating lines and bead-like granules. Shell substance thick, largely calcareous.

Interior of the pedicle-valve with a low, concave platform which extends over one-half the length of the shell, and is not hollowed on its anterior wall. The pedicle-area has been largely inclosed within the shell, making a distinct sheath or shelf, beneath which lie the apical portions of the central and lateral muscular scars. Crescentic scars scarcely defined.

The brachial valve is deep, with a high platform of about the same extent as that on the other valve, sloping inward near its anterior margin and continued axially into a strong septum which reaches nearly to the front of the valve. The anterior walls of the platform are broadly excavated, and close against the base of the septum are hollowed out into short conical cavities. The crescent is strongly developed, sharply pointed backward at its center. Its lateral curves are broad, reaching to the edge of the platform. Directly in front of its central angle lies a short, sharp, median ridge, which disappears near the center of the platform. Lateral and central muscular scars well developed.

Type, *Lingulasma Schucherti*, Ulrich. Hudson River group (Lower Silurian).

Trimerella, Billings. 1862.

(Plate 2, Figs. 9–12.)

Synonym; *Gotlandia*, Dall. 1870.

Shells thick; outline ovate.

Pedicle-valve with an erect and straight umbo, which is usually solid for the greater part of its length, but double-chambered toward its base; cardinal area very prominent; deltidium broad; deltidial ridges more or less conspicuous; deltidial callosities slightly developed; cardinal slope well-defined. Crescent sharply incised over its summit, but faint toward the sides, where it is connected with the broad lateral and terminal scars, which are not so distinctly outlined as in the allied genera. Platform long, narrow and strongly developed; platform vaults tubular, the

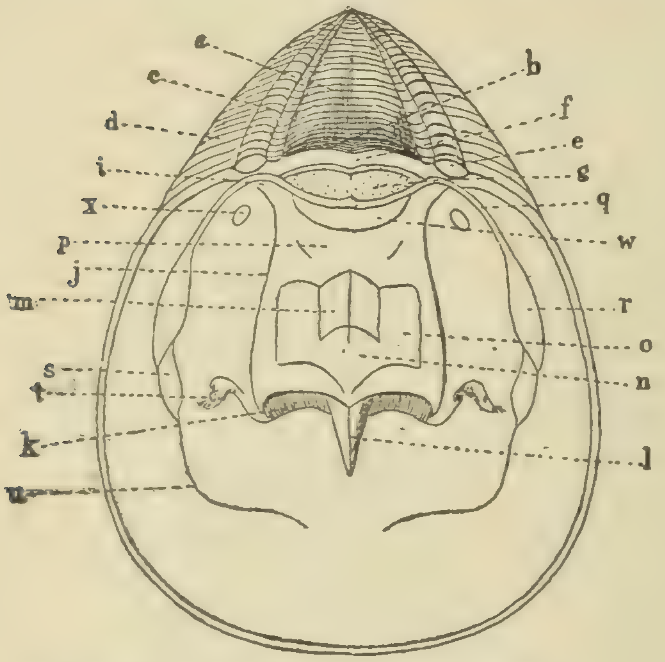


Fig. 245.— Pedicle valve of *Trimerella*.

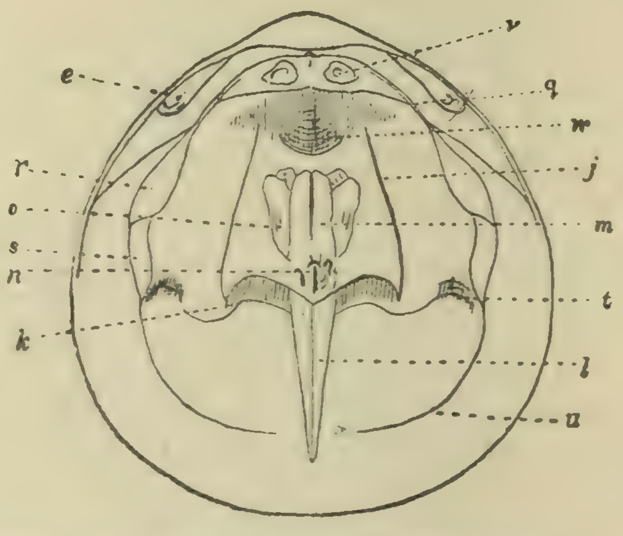


Fig. 246.— Brachial valve of *Trimerella*.

After Davidson and King.

a, deltidium.
b, deltidial slope.
c, deltidial ridges.
d, areal borders.
e, cardinal callosities.
f, cardinal facet.
g, lozenge.
h, cardinal buttress.
i, umbonal chambers.
j, platform.
k, platform vaults.
l, median plate.
m, median scars.
n, anterior scars.
o. lateral scars.
p, post-median scars.
q, crown }
r, side } crescent.
s, end }
t, transverse scars.
u, archlet (vascular sinuses).
w, sub-cardinal scars.
x, umbo-lateral scars.

e, cardinal sockets.
j, platform.
k, platform vaults.
l, median plate.
m, median scars.
n, anterior scars.
o, lateral scars
p, post-median scars.
q, crown }
r, side } crescent.
s, end }
t, transverse scars.
u, archlet (vascular sinuses).
v, cardinal scars.
w, sub-cardinal scars.

dividing wall being continued as a short septum in front of the platform. Muscular scars of the platform usually extremely faint, but under favorable preservation divisible into median and lateral components. Pallial sinuses faint.

Brachial valve with a marginal beak, which is much thickened in some instances, without producing a cardinal area, though making a prominent apophysis which is extended against the cardinal slope of the opposite valve. Crescent as in the other valve. Platform higher than in the pedicle-valve, its vaults extending scarcely so far backward. Anterior median septum long, often reaching almost to the margin. Muscular and pallial impressions faint.

Type, *Trimerella grandis*, Billings.

Distribution. Upper Silurian. (Illinois, Wisconsin, Ohio, Province of Ontario, Gotland, Farö.) Five species are known in American faunas and two additional species occur in the Swedish rocks.

Dinobolus, Hall. 1871.

(Plate 2, Figs. 1–4.)

Synonyms; *Conradia*, Hall, 1862; *Obobellina*, Billings, 1871.

Shell sub-circular; valves convex, thick.

Pedicle-valve with an acute and slender beak; cardinal area triangular, more or less elevated, but never so high as in TRIMERELLA or MONOMERELLA. Cardinal margins sometimes of considerable width. Umbo generally solid, but often slightly excavated on either side of a simple or double vertical wall, or buttress. Crescent distinct, its apex making a retral angle; narrow over the crown, widening into the great terminal scars. Platform low, broadly V-shaped on its anterior margin, which usually lies at about the middle of the valve; generally, with very short, flattened, abruptly conical vaults, but occasionally these vaults are of the same relative length as in TRIMERELLA, though much shallower. Central and lateral muscular scars on the platform usually distinct, the former lying in a depressed median groove, the latter occupying the greater portion of the surface. Subcardinal and anterior scars rarely discernible. Anterior median septum scarcely developed. Pallial sinuses faint.

Brachial valve with the beak submarginal, inconspicuous, usually not discernible; hinge-area very narrow. Crescent very strong, especially over the crown, where it makes a sharp posterior angle beneath the beak, sloping thence very gently, being almost transverse for about the width of the platform, then bending quite abruptly and being slightly interrupted at the position of the terminal scars, which are more approximate than in the opposite valve. In the type-species, the crown of the crescent, as usually developed, is a sharply incised, narrow furrow, bounded within by a broad elevation sloping to the position of the subcardinal scar, but not infrequently it is a ridge, bounded in front and behind by a deep furrow. This difference in appearance is due to the varying development of the anterior furrow, which is sometimes quite suppressed. Platform narrower and more sharply V-shaped than in the opposite valve; vaultsusually very short and abruptly conical. Lateral and central scars on the platform conspicuous, the latter lying in a deep median furrow, at the front end of which are sometimes seen the faint anterior scars. In the line of this furrow, directly in front of the apex of the crescent, lies the deep impression of the subcardinal muscle, which make a prominent feature on the cast, suggestive of the filling of the umbonal cavity, which it may be to some extent, although the apex of the beak is actually quite remote from it. From this point to the center of the crescent extends a short furrow, on either side of which lies the impression of an accessory scar, probably correlative with the umbo-lateral scars of RHINOBOLUS and TRIMERELLA. Pallial sinuses more or less distinct. Median septum low, but stronger than in the opposite valve. External surface smooth, or with concentric, sublamellose growth-lines.

Type, *Dinobolus Conradi*, Hall.

Distribution. Lower and Upper Silurian. Nine species have been recorded, one from the Lower Silurian of Brittany, another from Esthonia, three from the same division in North America, one in the Upper Silurian of North America, Gotland and Bohemia, and three from the same division in Great Britain.

Monomerella, Billings. 1871.

(Plate 2, Figs. 5, 6.)

Shell usually thick; outline varying from elongate-ovate to subcircular. Surfaces of contact of the valves sometimes conspicuously broad.

Pedicle-valve with a more or less elevated umbo, which may vary in height in a given species; umbonal cavity divided into two chambers by a longitudinal septum. Cardinal area large; deltidial ridges and deltidial callosities not always distinctly developed; cardinal slope usually well defined, merging anteriorly into the cardinal buttress, or umbonal septum; in some species this slope, or subtriangular area, is longitudinally divided by a furrow. The crescent is sharply impressed over the cardinal slope; terminal scars broad and distinct. Platform more or less developed; divided by the cardinal buttress, which extends nearly or quite its entire length. Muscular impression on the platform very large, covering the entire surface, but scarcely resolvable into separate scars. Anterior septum faint, usually imperceptible. Pallial sinuses sometimes clearly defined.

Brachial valve with the umbo seldom conspicuously developed, the umbonal cavity being usually simple and deep, but sometimes filled by a deposition of shelly matter. Crescent sharply impressed over the narrow cardinal slope, and produced into broad, indistinct, composite, terminal scars. Platform usually well developed and broadly excavate on its anterior walls, but sometimes scarcely discernible. Anterior and lateral scars sharply defined, giving a tripartite appearance to the platform. Anterior septum more strongly developed than in the opposite valve.

Type, *Monomerella prisca*, Billings.

Distribution, Upper Silurian. Eight species are known, six of which occur in the Niagara and Guelph faunas of North America, two on the island of Gotland and one in Livonia.

Rhinobolus, Hall. 1871.

(Plate 2, Figs. 7, 8.)

Synonym; *Obolellina* (*partim*), Billings. 1871.

General form of the shell as in Trimerella. Pedicle-valve, in the typical species, with an elevated, solid beak, having a broad and high deltidium, divided into a relatively narrow central area (which may be concave or convex), and broad deltidial ridges. Crescent and terminal scars as in Trimerella. Umbo-lateral scars sharply defined. Platform very low and incompletely developed, consisting of a broadly V-shaped elevation, with a raised anterior margin, and surface sloping abruptly backward to, or even below the general curvature of the internal surface. A faint longitudinal septum extends forward from the platform.

Brachial valve with low, sub-marginal, slightly-curved apex, and short deltidium. Crescent conspicuously developed. Platform as in the opposite valve, with the addition of a central scar, which gives the entire area a tripartite appearance. Median septum faint.

Type, *Rhinobolus Galtensis*, Billings (sp.).

Distribution. Upper Silurian ; Niagara and Guelph faunas of North America; two species.

Obolella, Billings. 1861.

(Plate 3, Figs. 5–7.)

Synonym; *Dicellomus*, Hall. 1871.

Shell inarticulated, ovate or suborbicular, lenticular, smooth, concentrically or radiately striated, sometimes reticulated by both radiate and concentric striæ. Ventral valve with solid beak and a small, more or less distinctly grooved area. In the interior of the ventral valve there are two elongated, sublinear or petaloid muscular or vascular impressions, which extend forward from near the cardinal scars, sometimes to points in front of the mid-length of the shell. These are either straight or curved, parallel with each other, or diverging toward the front. Between these, at about the middle of the shell, is a pair of small impressions, and close to the hinge-line a third pair, likewise small, and often indistinct. There is also, at least in some species, a small pit near the hinge-line, in which the groove of the area seems to terminate.

The dorsal valve has a small, nearly flat hinge-facet ; the minute beak is slightly incurved over the edge of the area. Beneath the beak there is a small subangular ridge, on each side of which there is a cardinal (?) scar. The elongate scars, which seem to correspond to the lateral impressions in the ventral valve, are here altogether in the upper half of the shell, diverging widely in their extension forward, and are generally very slightly impressed. In the cavity of the valve there is a low, rounded median ridge, which extends from a point near the hinge-line forward to a little below the mid-length of the valve. About the middle of the shell there are two small scars. These are usually striated longitudinally, the median ridge passing between them. The area is coarsely striated.

Type, *Obolella chromatica*, Billings.

Distribution. Cambrian —— (?) Lower Silurian. The description by MICKWITZ of the interior of a species from the Unguliten-sandstein, considered by him an OBOLUS (*O. Quenstedti*, Mickw.), renders the generic distinction between OBOLUS and OBOLELLA, for the time being, somewhat obscure. *Obolus Quenstedti* seems to possess the characters of OBOLELLA rather than of OBOLUS. The determination must rest upon future studies of *Obolus Apollinis*, Eichwald.

Elkania, Ford. 1886.

(Plate 3, Figs. 13, 14.)

Synonym; *Billingsia*, Ford. 1886.

Shells ovate or circular, biconvex; shell substance largely corneous and distinctly laminated. Apex of pedicle-valve marginal; within it is a broad subtriangular depression which merges into a deep central spoon-shaped cavity. Two narrow furrows diverge from its anterior extremity, separating the broad lateral muscular scars. Two small submarginal grooves pass from the beak outward, skirting the posterior portion of the lateral impressions, and appear to terminate in distinct subcircular scars situated near the lateral margins of the valve.

In the brachial valve is a thickened area in the umbonal region, presenting the appearance of a false cardinal area within the cavity of the umbo. This area is tripartite, bearing a deep, narrow central, and two broader lateral grooves; about its anterior margin lie two broad scars of the same character as the laterals of the other valve. There are also diverging furrows, which, starting at the marginal apex, pass over the edge of the thickened area, and are most deeply impressed at their anterior extremities.

Type, *Elkania desiderata*, Billings (sp.). (Cambrian; one species.)

Leptobolus, Hall. 1871.

(Plate 3, Figs. 8–12.)

Shells small, fragile, subovate in outline; shell substance semiphosphatic. Exterior with concentric growth-lines. The interior of the pedicle-valve shows a notably large cardinal area, which is sharply grooved. Beneath this area, in the bottom of the valve, is a broad depression extending nearly across the shell, and divided by a low median ridge, which bifurcates at its extremity, leaving between its branches a small central muscular impression. This impression is bounded on its sides by a crescentic muscular fulcrum, which extends parallel with the margins to the anterior portion of the shell. At a point back of their centers each gives off a transverse branch extending inward and backward. The portion of the valve lying between the anterior horns of the lateral semilunes is also deeply depressed, but its surface shows no markings. In the brachial valve the cardinal area is also well developed and distinctly grooved. The limits of the muscular scars are indicated by three septal ridges, one axial and one at either side. All these ridges are bifurcated at their anterior extremities.

Type, *Leptobolus lepis* Hall. Upper Silurian. Three species have been described, all from the Hudson River group and Utica slate of North America.

Paterula, Barrande. 1879.

(Plate 3, Fig. 15.)

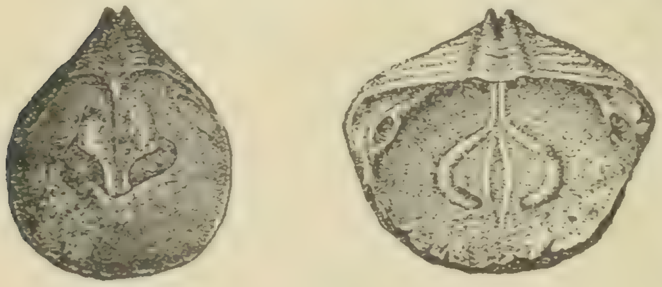
Shells small, oval, with broad margins of contact. Pedicle notch posterior and marginal. Interior of the pedicle-valve with two or four short, faint ridges diverging from the beak. External surface concentrically striated.

Type, *Paterula Bohemica* Barrande. Lower Silurian (Etage D). These shells are but imperfectly understood. Besides the single Bohemian species a somewhat similar form occurs in the Llandeilo of Great Britain, and in a lower Silurian limestone in the city of Quebec, Canada.

Obolus, Eichwald. 1829.

Synonyms; *Ungula*, Pander, 1830; *Aulonotreta* (*partim*), Kutorga, 1847; *Ungulites*, Bronn, 1848; Quenstedt, 1871.

Shells externally much like those of Obolella, but generally larger and somewhat flatter. The valves are unarticulated, both having broad, grooved cardinal areas, though the groove on the brachial valve is sometimes obsolescent. The interior of the pedicle-valve shows a pair of well-defined cardinal or posterior adductor impressions, just behind the

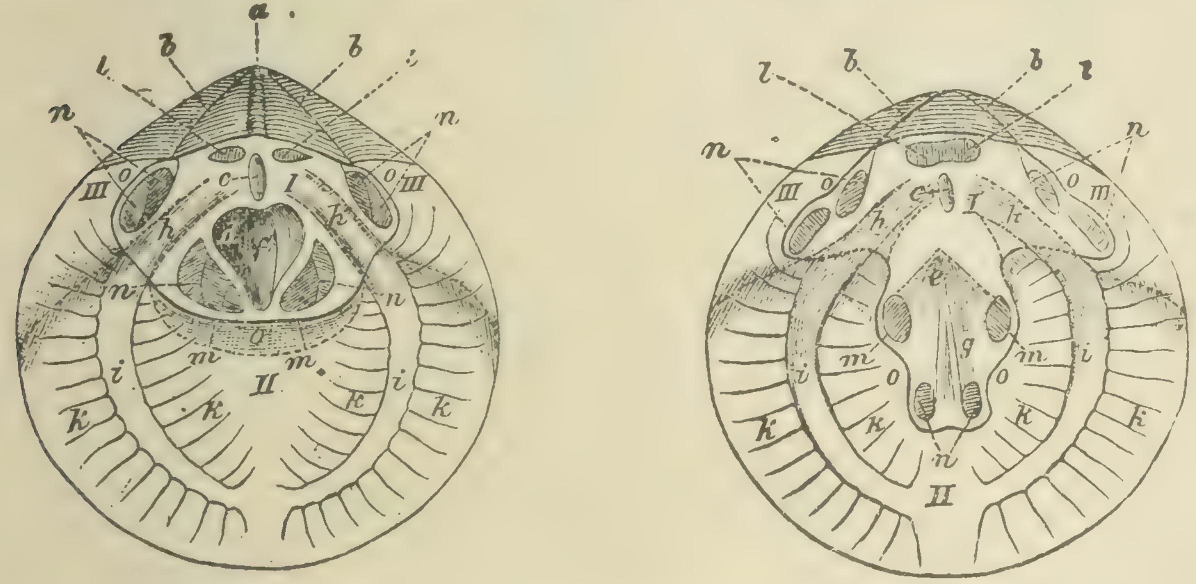


Obolus Apollinis.

Fig. 247.—Pedicle-valve. After Davidson.

Fig. 248.—Brachial valve. After Kutorga.

cardinal area and separated by a more or less developed median septum extending to about the center of the valve. The "laterals" are well developed and occupy a position not equivalent to the impressions in OBOLELLA which have been designated by this term, but more nearly to that of the terminal scars of the crescent in DINOBOLUS. The median area of the valve on each side of the septum is much thickened, and at its anterior edge lie the conspicuous central scars. In the brachial valve the cardinal and "lateral" (external or terminal) impressions are developed as in the opposite valve, and in the central region is a pair of curved impressions. These inclose an indistinct central scar.



Larger valve. **Smaller valve.**

FIGS 244, 245—Diagrammatic view of *Obolus Quenstedti*. After MICKWITZ.

a, Pedicle-groove; *b*, impression left by the advance of the lateral sliding muscles; *c*, median septum; *d*, cordate pit; *e*, sinus; *f*, median groove; *g*, median swelling; *h*, lateral grooves; *i*, impressions of vascular trunks; *k*, impressions of secondary sinuses; *l*, impressions of posterior adductors; *m*, impression of anterior adductors; *n*, impressions of sliding muscles; *o*, outline of splanchnocœle; I, splanchocœle; II, brachiocœle, III, pleurocœle

Type, *Obolus Apollinis*, Eichwald. Cambrian (Unguliten-schichten).

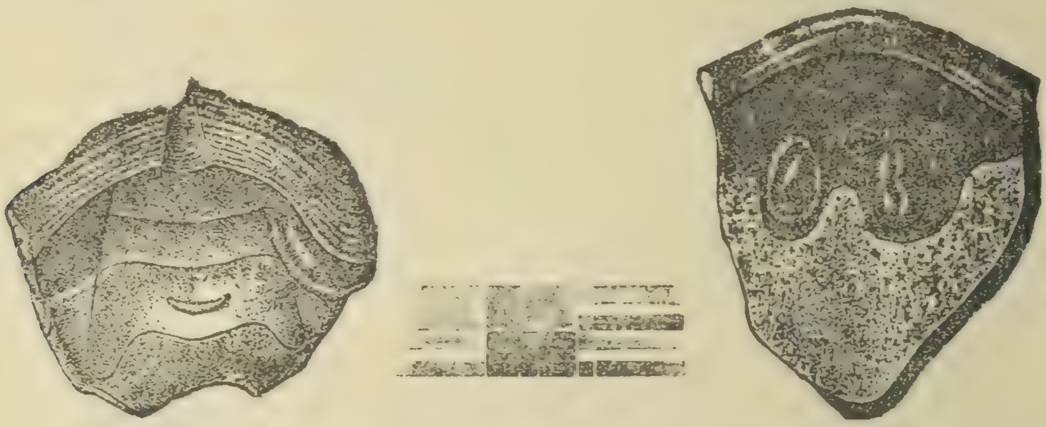
MICKWITZ has elaborated the internal impressions of his species *Obolus Quenstedti*, showing that it possessed a very complicated muscular system not unlike that of LINGULA. It is, however, not satisfactorily demonstrated that this species is a true OBOLUS.

Aulonotreta, Kutorga. 1848.

Synonym; *Acritis*, Volborth, 1869.

(This name was proposed to take the place of OBOLUS, Eichwald, 1829. The first type is *A. polita*, Kutorga = *Obolus Apollinis*, Eichwald; the second, *A. sculpta*, Kutorga = *O. antiquissimus*, Eichwald, was taken by Volborth as the type of Acritis. The latter species is imperfectly known. Mickwitz regards both Aulonotreta and Acritis as synomyms of Obolus).

Pedicle-valve with a broad, subquadrate muscular scar crossed on its posterior portion by a transverse band connecting what appear to be cardinal scars.



Aulonotreta antiquissima. After Volborth.

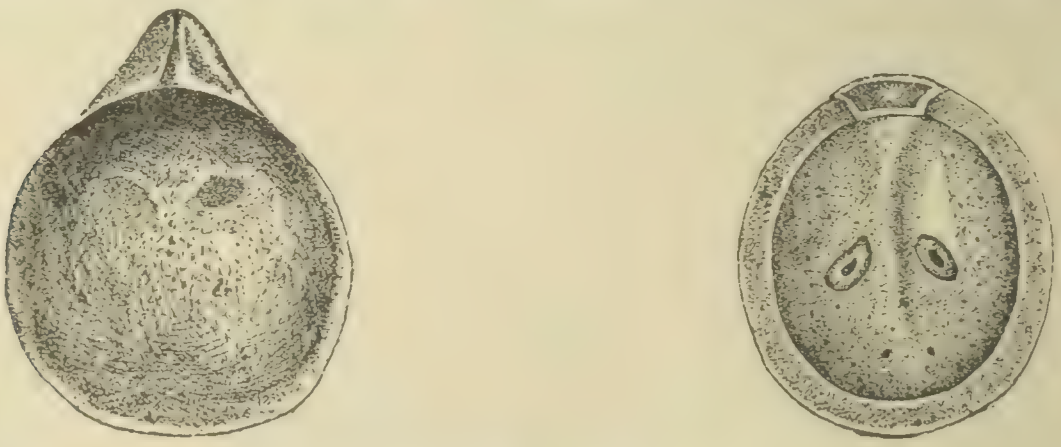
Fig. 246.—Interior of pedicle-valve. Fig. 247.—Interior of brachial valve.

In the brachial valve are two subcircular scars in the median region just within the posterior margin.

Type, *Aulonotreta antiquissima*, Eichwald. Cambrian.

Schmidtia, Volborth. 1869.

Pedicle-valve with a broad, centrally-grooved cardinal area, and, in the middle of the valve, two obliquely oval muscular impressions separated by an elevated ridge. In the brachial



Schmidtia celata. (Volborth.)

Fig. 248.—Interior of pedicle-valve. Fig. 249.—Interior of brachial valve.

valve is also a low median ridge and a single pair of oval impressions.

Type, *Schmidtia celata.* Cambrian (Unguliten-schichten).

Mickwitz considers this a synonym for Obolus.

Monobolina, Salter. 1865.

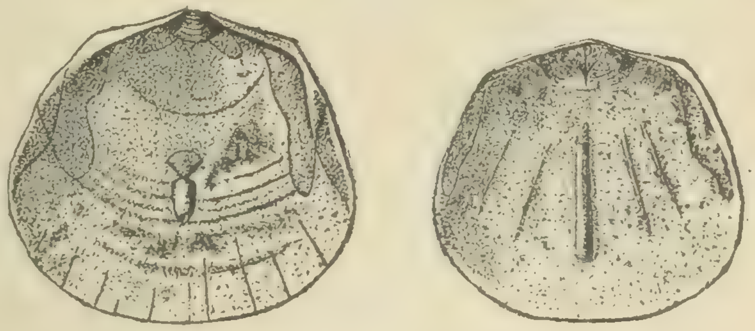
(Plate 4, Figs. 14, 15.)

Large oboloid shells with muscular scars concentrated along the median line.

Type, *M. plumbea*, Salter. Lower Silurian (Llandeilo).

Neobolus, Waagen. 1885.

Shell oboloid, with a somewhat transverse, slightly thickened posterior margin, which, in the pedicle-valve, is traversed by a broad, cross-striated pedicle-groove. The cardinal muscular scars lie close upon this groove; the central scars are faint, and in the figure, indistinctly defined, but are seen to abut against a short thickened ridge or knob in the middle of the shell. Marginal scars on both valves broad. In the brachial valve a strong longitudinally grooved callosity lies just within the cardinal margin, and this is more or less distinctly continued into a median septum. The arrangement of the muscular scars other than those referred to, is not fully understood.



Neobolus Warthi. After Waagen.
Fig. 250.— Interior of pedicle valve.
Fig. 251 — Interior of brachial valve.

Type, *Neobolus Warthi*, Waagen. Cambrian (India).

Spondylobolus, McCoy. 1852.

Shells subcircular, slightly narrowed towards the indistinct, short hinge-line; nearly equivalve, flattened. Small valve, with a slightly excentric apex; beneath which, on the interior, the substance of the valve is thickened into a wide, undefined boss. Opposite valve slightly longer, from the apex being perfectly marginal and slightly produced; channeled by a narrow, triangular groove below, the anterior end of which is flanked by two very prominent thick, conical, shelly bosses, representing hinge-teeth; substance of the valve thick, testaceous, not glossy, minutely fibrous, but not distinctly punc-

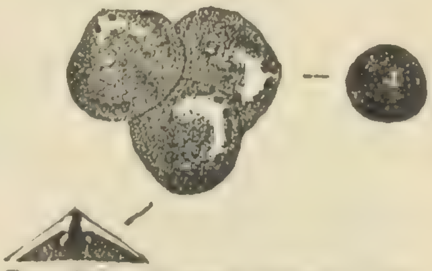


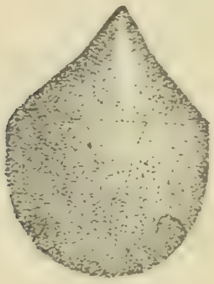
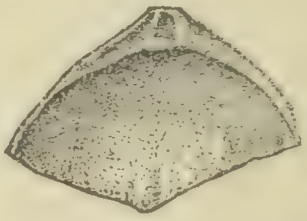
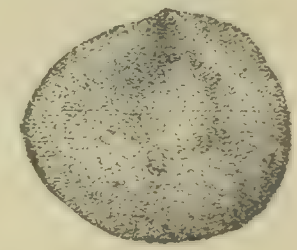
Fig. 252 — *Spondylobolus craniolaris*. After McCoy.

tated under a lens of moderate power, except by the ends of these fibers.

Type, *Spondylobolus craniolaris*, McCoy. Lower Silurian (Llandeilo).

Mickwitzia, Schmidt. 1888.

Shells large, thick, inequivalve. Brachial valve flat, circular; pedicle-valve oval, convex, produced into an acute apex, beneath which lies a triangular, more or less distinctly developed cardinal area. Valves not (?) articulated. Shell-substance composed of thin, coarsely punctate layers alternating with prismatic laminæ which are traversed by scattered vertical canals. Surface covered with radiating striæ. Shell composed of calcic phosphate.

Mickwitzia monilifera. (After Schmidt)

Fig. 253.—Pedicle-valve.

Fig. 254.—Interior of same valve.

Fig. 255.—Exterior of brachial valve.

Type, *M. monilifera*, Linnarsson. Lower Cambrian.

Schizobolus, Ulrich. 1886.

(Plate 3, Figs. 16–19.)

Shell oval, slightly inequivalved; cardinal margins somewhat thickened. Shell substance largely corneous; external surface concentrically lined. In the pedicle-valve, the passage is very short, usually no more than a notch on the margin. From its inner end a median ridge extends one-third the distance across the valve, and this is flanked on each side by a low muscular callosity. Narrow curved lateral scars extend from the post-lateral margins of this callosity, continuing to, or beyond the center of the valve. In the brachial valve is a narrow thickened band directly within, and parallel to the posterior margin. Muscular thickening as in the opposite valve. No curved lateral scars.

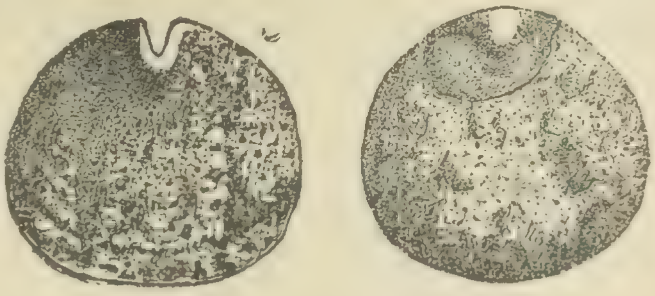
Type, *Schizobolus truncatus*, Hall (sp.). Devonian.

A single species has been described; from the Genesee shales.

Discinolepis, Waagen. 1885.

Shell of very small size with two unequal valves, which are very flat, leaving scarcely any room for the animal between them.

The pedicle-valve depressed convex, the apex only being a little elevated and removed from the margin towards the median part of the valve. The posterior margin of the valve near the apex is broadly notched by a deep incision reaching to the beak.



Discinolepis granulata. After Waagen.

Fig. 256.—Pedicle-valve. Fig. 257—Brachial-valve.

The brachial valve is similar in shape to the other, with a slightly elevated eccentric apex, but without an incision.

The surface in both valves is either smooth or finely granulose.

Type, *Discinolepis granulata*, Waagen. Cambrian (India).

Paterina, Beecher. 1891.

Valves semi-elliptical in outline, subequal, the pedicle-valve being slightly the more elevated. Hinge line equal to the greatest width of the shell, without cardinal area. Pedicle passage not limited except by the posterior margins of the valves.

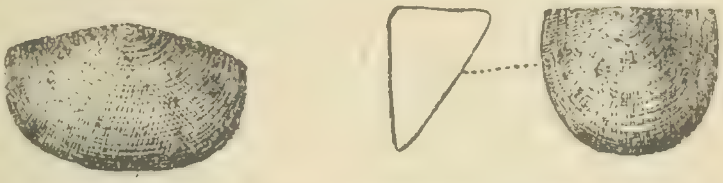


Fig. 258.—*Paterina Labradorica.* (Walcott.)

External surface covered with concentric lines terminating abruptly on the cardinal margin. Shell substance corneous.

Type, *Paterina Labradorica*, Billings (sp.). Cambrian. Only a single species of the genus is known.

Kutorgina, Billings. 1861.

(Plate 4, Figs. 11–13.)

Shells inequivalve, transverse or elongated. Hinge-line nearly equaling the greatest width of the shell. Pedicle-valve convex, greatly elevated at the beak, which is more or less incurved. Cardinal area very narrow, and divided by a wide pedicle-fissure. Brachial valve flat or slightly convex, beak marginal. Cardinal area very feebly developed. The posterior portion of the valves is therefore unclosed for nearly the entire length of the hinge-line.

External surface covered with concentric lines, which terminate abruptly at the cardinal line.

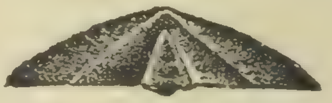
Shell substance calcareous.

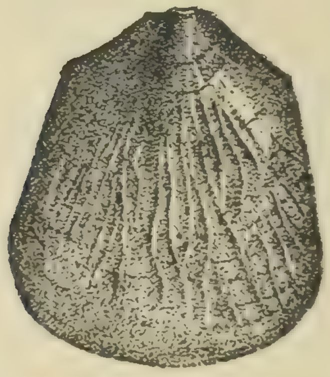
Type, *Kutorgina cingulata*, Billings. (Cambrian.)

A number of species from North America, Sweden and Great Britain have been referred to this genus, but it is doubtful if they are all congeneric. Some of them probably belong to Paterina, Beecher, and others to Schizopholis, Waagen.

Schizopholis, Waagen. 1885.

Shells of very small size. Pedicle-valve slightly elevated, with a somewhat prominent marginal apex, below which is a small triangular area, crossed in the middle by a triangular fissure, a little widened at the top, forming a kind of foramen, placed just at the extremity of the apex. Brachial valve flat; imperforate.





Schizopholis rugosa. **Pedicle-valve. After Waagen.**
Fig. 259.— Upper view.
Fig. 260 — Cardinal view.

Shell surface finely granular.

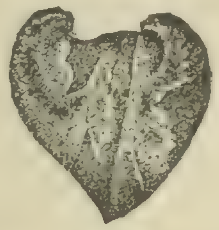
Of the internal characters of the genus nothing is known.

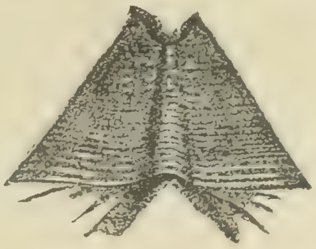
Type, *Schizopholis rugosa*, Waagen.

Distribution. Cambrian (India: North America, *S. Latourensis*, Matthew (sp.); *S. pannula*, White (sp.).

Volborthia, von Möller. 1873.

Shell convex, very inequivalve; contour as in Kutorgina. Pedicle-valve elevated, incurved at the apex, and with a broad, sharply defined cardinal area, divided by a low convex ridge passing from the beak to the cardinal margin. There is no foramen.





Volborthia recurva. After von Möller.
Fig. 261.—Profile. Fig. 262 —Cardinal view.

Brachial valve convex; beak marginal; cardinal area not developed. Muscular impressions not known. Surface covered with concentric lines. Shell substance calcareo-corneous.

Type, *Volborthia recurva*, Kutorga (sp.). Lower Silurian.

Iphidea, Billings. 1872.

(Plate 4, Figs. 4, 5.)

Pedical-valve subconical; beak apical. Hinge-line short, nearly straight. Cardinal slope flattened, forming an imperfectly defined area, which is divided medially by a convex ridge or pedicle-covering. Foramen circular, apical.

Brachial valve moderately convex: most elevated at the beak. Internal characters not known. External surface covered with cencentric striæ, which are continued over the area of the pedicle-valve. Shell substance corneous.

Type, *Iphidea bella*, Billings.

Distribution. Cambrian (Newfoundland, Vermont, Arizona, Sweden).

Acrothele, Linnarsson. 1876.

(Plate 3, Figs. 24–27.)

Shell corneous, composed of several laminæ. Pedicle-valve slightly conical, with excentric umbone, pierced by a minute foramen, in front of which there are two small wart-like protuberances; the area between the umbone and the posterior margin is usually a little flattened. Brachial valve with marginal umbone; in the interior of which there are two oblong, diverging muscular scars, close to the posterior margin, and two small rounded scars near the middle. The muscular scars are separated by a longitudinal ridge.

Type, *Acrothele coriacea*, Linnarsson.

Distribution. Cambrian — Lower Silurian (New Brunswick, Utah, Ireland, Bohemia, Sweden).

Acrotreta, Kutorga. 1888.

(Plate 3, Figs 28–30.)

Pedicle-valve subconical, the posterior slope being flattened, having a triangular form and resembling a cardinal area. This slope is divided medially by a groove, widening downward; at the apex of the valve is a circular foramen. On the interior this foramen penetrates a mammiform callosity.

Brachial valve flat or depressed convex; apex marginal; on the interior is a stout median ridge flanked by a large anterior and a smaller posterior pair of muscular impressions.

Exterior concentrically striated. Shell substance corneous.

Type, *Acrotreta subconica*, Kutorga.

Distribution, Cambrian — (?) Lower Silurian.

Conotreta, Walcott. 1888.

(Plate 4, figs. 1–3.)

Synonym: *Geinitzia*, Hall. 1889.

Pedicle-valve conical, its height being greater than its length; apex with evidence of the external opening of the sipho. From the apex, a shallow furrow extends to the posterior margin, increasing in width downward. In young shells the posterior wall of the shell conforms to the curvature of the rest of the surface, interrupted only by the longitudinal depression, but, with increase in size, this area becomes distinctly flattened as in ACROTRETA. Surface covered with sharp concentric striæ which make a slight upward curve as they cross the foraminal groove.

On the interior a strong apical callosity surrounds the probable position of the foramen. This is somewhat produced anteriorly into a short, sharp ridge, on either side of which lie two other ridges, with evidence of a third on the lateral slopes.

Type, *Conotreta Rusti*, Walcott. (Lower Silurian.)

The single species described occurs in the Trenton limestone of New York and the Utica slate of Kentucky.

Discinopsis, Matthew. 18‘‘2.

(Plate 3, Figs. 20, 21.)

Shell subcircular in outline. Surface depressed-conical, apices excentric, not marginal. Pedicle-valve with the apex truncated by a circular foraminal aperture (?). The interior of this valve is characterized by a pair of deep, diverging furrows, passing forward from the beak or internal foraminal opening, in broad curves which converge toward the anterior margin but without meeting. These furrows inclose a thickened and somewhat elevated central area, which, in the subumbonal region, is apparently free, projecting for a short distance, like a narrow, triangular shelf, beneath which the foramen probably opened. A faint longitudinal ridge passes from the apex of the shelf to the anterior margin.

Shell-substance tenuous, apparently corneous. External surface covered with more or less prominent, sometimes lamellose concentric growth-lines, crossed by fine, gently curved, radiating striæ which are usually more prominent when the concentric lines are exfoliated.

Type, *Discinopsis Gulielmi*, Matthew. (Cambrian.)

A single species from the St. John group of New Brunswick.

Linnarssonia, Walcott. 1885.

(Plate 3, Figs. 22, 23.)

Shells transversely ovate or subcircular; valves convex. Pedicle-valve with somewhat elevated submarginal apex, perforated by a circular foramen; without cardinal area or thickened cardinal margin. On the interior there is a conspicuous mammiform tubercle surrounding the opening of the foramen, and two small posterior submarginal tubercles.

In the brachial valve are similar tubercles, though less conspicuously developed; between them lies an axial ridge which is broadened over the central portion of the shell; at the sides are shorter, divergent ridges.

Shell substance calcareo-corneous; lamellar. Surface smooth or with concentric growth-lines.

Type, *Linnarssonia transversa*, Hartt (sp.).

Distribution. Cambrian—(?), Lower Silurian (New York, New Brunswick, Canada, Sweden, Wales).

Mesotreta, Kutorga. 1848.

(Plate 4, Fig. 21.)

Shell patelliform, depressed-conical; apex central, perforated by a foramen; no cardinal area or flattening (?). Surface ornamented by concentric growth-lines bearing spines. Pedicle-valve only known.

Type. *Mesotreta tentorium*, Kutorga (Lower Silurian. Russia.).

Trematobolus, Matthew. 1893.

Shell biconvex: valves lenticular. Pedicle-valve with a low, striated hinge-area, the anterior margin of which bears two small articulating apophyses or teeth. Foramen in the center of the shell, opening obliquely backward; between it and the apex is a long tapering groove, with a corresponding ridge on the interior. Muscular scars submarginal, divisible into a posterior and anterior pair.

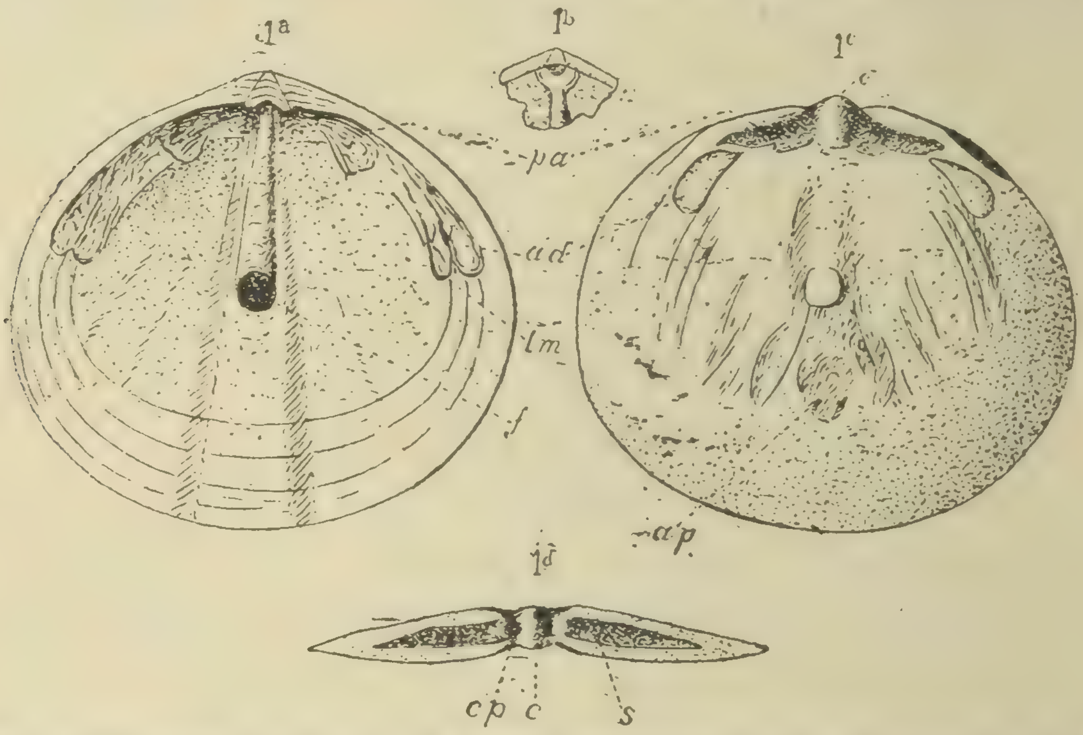


FIG. 263.– *Trematobolus insignis.* 1*a*, interior of pedicle-valve; 1*b*, internal cast of brachial valve; 1*c*. cardinal view of brachial valve; 1*d*, inside of beak of pedicle-valve; *pa*. posterior adductors: *ad*, adjustors; *lm*, lateral muscles; *t*, teeth; *f*, foramen; *s*. sockets; *c*, cardinal process; *cp*, cardinal pits. (MATTHEW.)

Brachial valve, with long, narrow dental sockets and distinct cardinal process. Anterior and posterior muscular scars submarginal and less remote than in the opposite valve.

Surface covered with fine concentric growth-lines and faint traces of radial striæ.

Shell substance calcareo-corneous (?)

Type, *Trematobolus insignis*, Matthew.

Distribution. St. John group: Hanford Brook, New Brunswick.

Siphonotreta, de Verneuil. 1845.

(Plate 4, Figs. 22–26.)

Shell elongate-oval, inequivalve; valves unarticulated. Pedicle-valve the more convex, with a straight, elevated, conical, and perforated beak, the circular foramen opening at the apex and communicating with the interior of the shell by a tubular canal, which narrows slightly as it passes inward. No cardinal area or deltidium is present, the growth-lines passing between the beak and the posterior margin as elsewhere on the shell. Brachial valve depressed-convex; beak marginal; posterior margin regularly arched and thickened. Interior of pedicle-valve with muscular impressions confined to the umbonal region. Adjacent to the opening of the sipho, and just within the cardinal margin lie two elongate scars which are accompanied on either side by broader, somewhat expanded or flabellate, simple and less distinct impressions. Directly in front of the middle pair and in the axis of the shell lies a small central scar, and at either side of it a transversely elongate impression. These latter impressions are distinctly separated from the former by a transverse ridge.

In the brachial valve the impressions are equally concentrated, the entire muscular area being bounded on its posterior margin by a prominent ridge which, at the sides, merges into a compound lateral scar. The central portion of the area is much depressed and is divided axially by a narrow ridge or septum.

Shell ornamented with concentric lines and ridges, the epidermal layer bearing hollow spines, which are distended at the base. Shell-substance calcareo-corneous, the layers beneath the epidermis being punctured by radiating and branching tubules. These layers are concentric and not parallel to the internal surface.

Type, *Siphonotreta unguiculata*, Eichwald.

Distribution. Lower — Upper Silurian (Baltic Provinces, England, Scotland, New York, Minnesota).

Schizambon, Walcott. 1884.

(Plate 4, Figs. 16–20.)

Shell ovate or oblong; pedicle-valve the more convex, with a short obtuse marginal beak. Foramen in front of the beak, oval in outline and connected with the apex by a tapering groove or progressive cicatrix. Interior of both valves with faint diverging lateral ridges indicative of muscular areas.

Surface covered with concentric growth lines which may be spiniferous. Shell substance calcareo-corneous.

Type, *Schizambon typicalis*, Walcott. (Lowest Silurian [Primordial ?]).

Species having the pedicle-passage situated anteriorly as in *S. typicalis*, but having it developed as a tube, as in Siphonotreta, have been referred provisionally to Schizambon (*S. fissus*, Kutorga, *S. Canadensis*, Ami). These are much larger and more strongly spinose shells than *S. typicalis*, and also occur in faunas of later age. (Trenton.)

Helmersenia, Pander. 1861.

(Plate 4, Figs. 6, 7.)

Shell having the general form of Obolus, with a conspicuous cardinal area depressed in the center by a broad low pedicle-groove (?). Apex of the pedicle-valve truncated by a circular opening, which is not produced into an internal tube. Muscular impressions indistinct.

No specific name has been proposed for the typical form. (Lower Silurian of Russia.)

Orbicella, D'Orbigny. 1849 (1847 ?).

(Plate 4, Figs. 8–10.)

Synonym; *Keyserlingia*, Pander. 1861.

Shell inequivalve, subcircular or oval. Pedicle-valve more or less conical with an excentric apex, from which diverge posteriorly two low ridges inclosing a flattened triangular area divided in the center by a vertical fissure. The lines of growth cross the hinge-line, forming in the center a faintly depressed triangular groove, as in Helmersenia and Obolus. In the interior of the valve a closed tube is continued from the external fissure, in the axial line. The first one-third of this tube is swollen and thickened, but thenceforward it passes, with parallel sides, to the anterior margins, where it is probably closed Brachial valve more depressed, its greatest convexity being in the center. Cardinal area as in the opposite valve, but narrower. A closed tube, beginning in a swelling just in front of the cardinal line, is continued from the center of the shell to the anterior margin as an open channel.

Type. *Orbicella Buchi*, de Verneuil (sp.). (Lower Silurian of Russia.)

Discinisca, Dall. 1871.

Synonym; *Discina*, of most authors.

Shells orbicular; brachial valve the more convex; pedicle-valve more or less flattened, concave or depressed. Apices of both subcentral or subposterior. Pedicle-valve with a small septum as in Discina, behind which is an impressed disc or area, externally concave and internally elevated. This is perforated by a longitudinal fissure, extending from a short distance behind the septum nearly to the posterior margin, which is often slightly indented behind it. Shell more or less horny in texture, minutely tubulose. Brown or yellowish in color. Animal with labial folds united. Spiral arms free, their apices being directed toward the pedicle-valve. Oral cirri long and flexible; setæ of the mantle stiff and brittle. Adductor muscles, four; sliding-muscles also four.

Type, *Discinisca lamellosa*, Broderip (sp.).

Distribution. American seas (Atlantic, Pacific, Carribean), China. Fossil: Mesozoic (?) to Tertiary.

Discina, Lamarck. 1819.

Synonym, *Orbicula*, Sowerby. 1818 (not Cuvier. 1798).

Shell orbicular, calcareo-corneous, thick, impunctate, lamellar. Valves convex. A small, sharp, longitudinal septum rises from the center of the lower or pedicle-valve, of a subtriangular shape, covering and hiding a small tubular perforation of the apex of the shell. This perforation is very oblique, and from its internal opening a groove extends backward nearly half-way to the posterior border of the shell. The anterior muscular scars meet in front of the septum and form a semilunar elevation with the points directed backward. The posterior scars in the lower valve are small and widely separated. On the external surface the foramen appears nearly in the middle of the shell and the furrow is continued anteriorly for a short distance. Upper or brachial valve convex, apex subcentral; a slight median longitudinal callus internally. There is no strongly impressed disk about the foramen as in Discinisca; color brownish yellow.

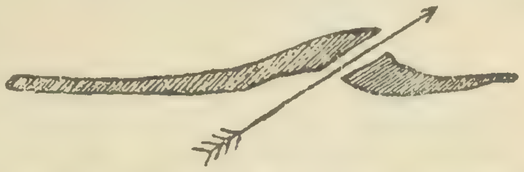


Fig. 264.—Vertical section of the pedicle-valve of *Discina striata*. After Davidson.

Type, *Discina striata*, Schumacher.

Habitat. Cape Palmas, West Africa. (Recent; but one species known.)

Orbiculoidea, D'Orbigny. 1847.

(Plate 5, Figs. 11–17.)

Synonym: *Discina* of authors. Not *Orbiculoidea*, Davidson. 1856.

Shells subcircular or subelliptical in outline, inequivalve. Apices excentric. Pedicle-valve depressed-convex or flattened, with the apex slightly elevated and inclined posteriorly. On the exterior of the valve a narrow pedicle-furrow, abruptly intercepting the ornamentation but not penetrating the substance of the shell, begins just below and behind the apex, extends over a greater or less portion of the radius of the valve, and, at its distal end, is produced into a short tubular sipho, which traverses the substance of the shell obliquely backward, emerging on the interior surface, where it produces a narrow groove, and usually terminates before reaching the margin of the valve. On the interior, the position of the external groove is marked by a thickened ridge extending from the apex, and this is continuous with the thickened margins of the internal groove, which, in advanced age, may become so developed as to envelop this groove, except at its outer end.

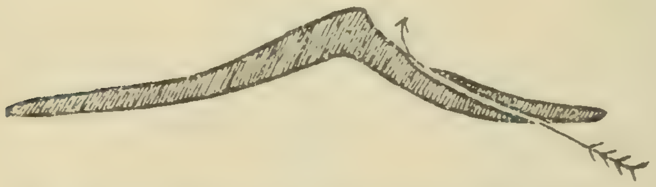


Fig. 265 — Vertical section of the pedicle-valve of *Orbiculoidea*.

The larger or brachial valve is depressed-conical, with the apex more strongly directed backward than in the opposite valve. The interior shows a fine longitudinal ridge or septum extending from the apex forward. Otherwise the internal markings are not satisfactorily known.

Shell substance composed of alternating lamellæ of corneous and mineral matter, the latter often removed in fossilization, making the shell appear essentially phosphatic. Surface ornamentation usually consisting of fine, crowded or distant, sometimes lamellose, concentric lines, occasionally crossed by radiating lines or ridges.

Type, *Orbicula Morrisi*, Davidson. (Wenlock limestone.)

Distribution. Lower Silurian — Cretaceous (?).

Subgenus **Schizotreta,** Kutorga. 1848.

(Plate 5, Figs. 1–4.)

Shells as in *Orbiculoidea* but having the relative convexity of the valves reversed, the pedicle-valve being the more convex.

Type, *Schizotreta elliptica*, Kutorga. (Lower and upper Silurian.)

Subgenus **Rœmerella,** Hall. 1892.

(Plate 5, Figs. 9, 10.)

Brachial valve convex; pedicle-valve concave.

Type, *Rœmerella grandis*, Vanuxem (sp.) (Hamilton group = Middle Devonian.)

Subgenus **Œhlertella,** Hall. 1892.

(Plate 5, Figs. 5–8.)

Contour as in ORBICULOIDEA. Attachment aided by the projecting margin of the brachial valve. Pedicle-area conspicuously elevated; pedicle-passage an open fissure extending to the margin of the valve. Floor of the pedicle-passage (listrium) tripartite. Muscular scars not observed. External surface covered with concentric striæ.

Type, *Œhlertella pleurites*, Meek (sp.) (Waverly sandstone = lower Carboniferous.)

Subgenus **Lindstrœmella,** Hall. 1892.

(Plate 5, Figs. 18, 19.)

Shells with outline, contour and pedicle-characters as in ORBICULOIDEA. Brachial valve with a faint median septum and two strong approximiting ridges or muscular fulcra, beginning just behind a transverse line passing through the apex and rapidly converging to meet the median septum. Anterior adductor scars lying between these ridges and the median septum; a circular muscular scar at the posterior extremity of each ridge.

In the pedicle-valve, the foramen has essentially the structure of ORBICULOIDEA, but its distal margins, though lying in close juxtaposition, appear not to have been united.

Type, *Lindstrœmella aspidium*, Hall. (Hamilton group = middle Devonian).

Trematis, Sharpe. 1847.

(Plate 6, Figs. 1–8.)

Shell subcircular or transversely oval in outline. Pedicle-valve unevenly convex, more or less depressed over the posterior region; apex at, or behind the center; directly beneath it begins the pedicle-fissure, which transects the shell, vertically widening to posterior margin with straight or outwardly curving edges. Brachial valve evenly convex, with its apex marginal and slightly projecting. On the interior, the pedicle-valve shows a faint median furrow extending from the angle of the fissure to the apex of the shell; this groove widens at its apical termination and may represent a point of muscular attachment. The sides of the fissure are often thickened by callosities similar to those sometimes seen in species of Orbiculoidea. From the apex of the valve extend radiating and branching vascular sinuses.

In the brachial valve the posterior margin is much thickened and broadly grooved to allow the extrusion of the pedicle. This thickening does not take the form of a cardinal area or shelf, but is rather a callosity closely appressed against the interior surface of the shell, the central portion being projected beyond the margin of the pedicle-valve. Directly below and in front of this area are two transversely elongate scars, adjustors or posterior adductors, which are usually partly concealed by the progressive overgrowth of the cardinal thickening. A faint median septum begins between these scars and passes forward, becoming more prominent over the tongue-shaped median elevation which separates the large central scars. These impressions are oblique and are not simple, each appearing to be composed of two, if not three distinct scars, making a posterior, a median and an anterior pair. What appears to be the posterior pair is small, and sometimes quite sharply defined, the central pair very much larger, and the anterior pair narrow, situated at either side of the angle of the median callosity and separated by its apex The specialization of the first of these scars is not satisfactorily established; the entire impression is deeply excavated. In some well preserved specimens, there is also evidence of external, marginal scars lying just in front of the outer ends of the posterior adductors.

Surface of both valves more or less completely covered by a beautiful ornamentation consisting of punctures or small pittings of various depth, arranged either in quincunx (*T. terminalis*) or in radiating rows; in the latter case they may be distant from one another without intervening ridges (*T. umbonata*), or lie in radiating furrows, when they are either circular (*T. millepunctata*) or subrectangular (*T. Ottawensis*).

Shell-substance composed of an outer calcareous layer with a series of inner corneous lamellæ. The outer layer varies in thickness in different species, and is coarsely punctated by the pittings constituting the surface ornamentation. The corneous layers are impunctate.

Type, *Trematis terminalis*, Emmons (sp.).

Distribution, Lower (to upper?) Silurian.

The species are largely American and mainly confined to the faunas of the Trenton and Hudson River groups.

Schizocrania, Hall and Whitfield. 1875.

(Plate 6, Figs. 9–13.)

Shells sub-circular in outline, inequivalve, unarticulated. Pedicle-valve flat or concave; apex subcentral. A deep triangular notch extends from just behind the beak to the margin, where its arc is equal to about one-sixth of the periphery. The apex of this broad pedicle-notch is occupied by a triangular transverse plate or listrium varying in size with the age of the shell, but extending for one-fourth to one-third the length of the opening. Surface marked by concentric growth-lines. On the interior no muscular impressions are visible. Brachial valve more or less convex, with the beak marginal. External surface radiately striated. The interior bears a pair of strong posterior adductor scars, lying close together in the unbonal region; their outline is elongate-ovate, indicating a progressive increase in size, and they frequently appear to be divisible into anterior and posterior elements. In front of them, at about the center of the valve, are the small and faint anterior adductor impressions. A low median ridge extends from the apex to beyond the center of the valve. External surface marked by elevated striæ radiating from the beak.

Substance of the shell composed of perlaceous calcareous laminæ which constitute the most of the shell. The inner layers appear to be corneous. All are impunctate (?).

Type, *Schizocrania filosa*, Hall.

Distribution. Lower Silurian to (?) Devonian. The genus is American and the typical species are found in the fauna of the Hudson River group.

Crania, Retzius. 1781.

(Plate 6, Figs. 14-23,)

Synonyms. *Numulus*, Stobœus, 1732; Waller, 1778; *Anomia*, Linné. 1760; *Ostracites*, Beuth, 1776; *Patella*, Müller, 1776; *Criopus*, *Criopoderma*, Poli, 1791, 1795; *Orbicula*, Cuvier, 1798; Lamarck, 1799; *Orbicularius*, Duméril, 1806; *Craniolites*, Schlotheim, 1820; *Choniopora*, Schauroth, 1854.

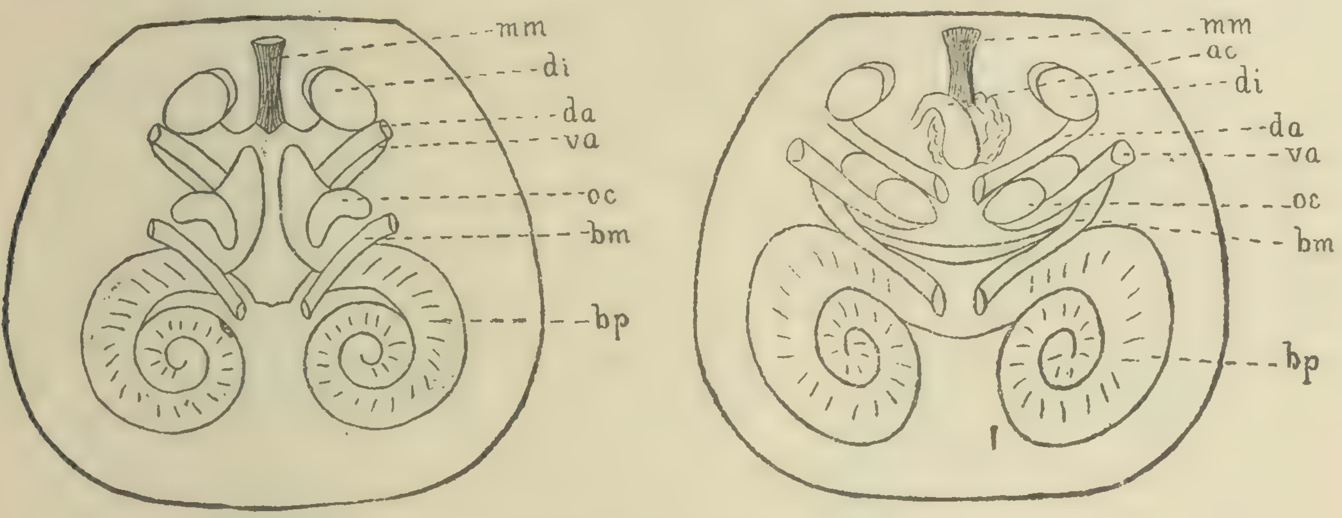
Shell inequivalve, inarticulated, without perforation for a pedicle; subcircular in outline, generally somewhat transverse across the posterior margin; attached by the apex or the entire surface of the lower valve. Ventral or lower valve depressed-conical or conforming to the surface to which it is attached. Dorsal or upper valve more or less conical with a subcentral, posteriorly directed apex. External surface of the valves usually smooth, sometimes spinose or with concentric or radiating striæ. In the interior of both valves are two pairs of large adductor scars, the posterior of which are close upon the margin and widely separated, the anterior near the center of the shell and close together, more approximate in the lower than in the upper valve. These posterior scars are often strongly elevated on a central callosity which surrounds their broad and thickened margins. Impressions of the pallial genital canals anterior. The margin of the lower valve is usually coarsely digitate.

Shell-substance calcareous; strongly punctated by vertical canals which become subdivided toward the epiderma lsurface.

Animal provided with two spiral arms, whose apices are directed toward the dorsal valve. The alimentary canal forms a convolution on the right side, the anus opening near the center of the ventral valve. Liver large; genital glands six in number, two in each mantle lobe and two in the visceral cavity. Mantle without marginal setæ.

Type, *Crania craniolaris.* Linné.

Distribution. Lower Silurian to Recent (Northern Atlantic, Mediterranean, Caribbean, Florida, Japan).



Crania anomala. After HANCOCK.

FIG. 266.—Dorsal surface of the animal. FIG. 267.—Ventral surface.

mm, mesenteric muscle; *di*, divaricators; *da*, dorsal adjustors; *va*, ventral adjustors; *oc*, occlusors; *bm*, brachial muscles; *bp*, brachial process; *ac*, alimentary canal (According to JOUBIN, this organ should have a median, not lateral termination).

Subgenus **Ancistrocrania**, Dall. 1877.

(Plate 7, Figs. 1, 2.)

(Synonym; *Cranopsis*, Dall. 1871.)

Lower valve attached; upper valve with two internal apophyses or muscular fulcra diverging from the apex.

Type, *Ancistrocrania Parisiensis*, Defrance (sp.). Cretaceous.

Subgenus **Craniscus**, Dall. 1871.

(Plate 7, Fig. 3.)

(Synonym; *Siphonaria*, Quenstedt. 1851.)

Attached valve divided by a transverse and a longitudinal septum into three cells, the posterior containing the muscular impressions.

Type, *Craniscus tripartitus*, Münster (sp.). Jurassic.

? Subgenus **Pseudocrania**, McCoy. 1851.

(Plate 7, Figs. 11–13.)

(Synonym; *Palæocrania*, Eichwald. 1860.)

Shell free; valves convex; margins of contact broad and flat; upper valve with three pairs of muscular scars, the largest submarginal; a smaller median pair, and an anterior pair with the members in apposition. In the lower valve the median and anterior scars are coalesced; the cardinal scars in the as other valve.

Type, *Pseudocrania antiquissima*, Eichwald (sp.). (Lower Silurian.)

Subgenus **Craniella,** Œhlert. 1888.

(Plate 7, Figs. 4, 8.)

Shell somewhat irregular, outline subcircular or subquadrangular. Lower valve thin, adhering by its entire surface; upper valve conoidal, more or less elevated; apex subcentral, posterior; interior of the upper valve without a well defined border; impressions of the adductors large, very distinct, four in number, of which the posterior two are quite distant, the anterior two subcentral, somewhat smaller, closely approximate or even confluent; from near each of the posterior impressions starts a vascular sinus, which is broad, strongly sinuous near its point of departure, narrowing gradually in following the contour of the valve, emitting from its marginal side dichotomizing secondary branches.

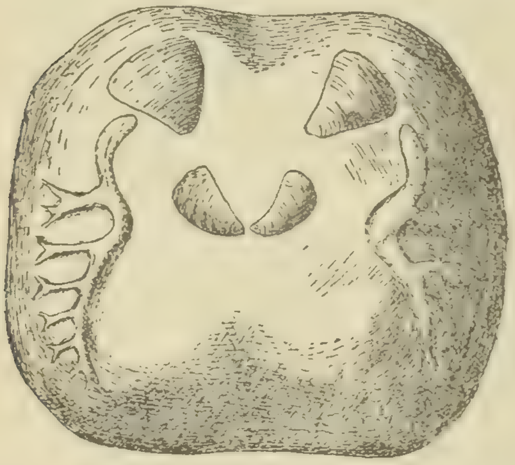


Fig. 268.— *Craniella Meduanensis*. After Œhlert.
Internal cast of upper valve.

Type, *Craniella Meduanensis*, Œhlert.

Distribution. Lower Silurian to Devonian.

Subgenus **Cardinocrania,** Waagen. 1885.

(Plate 7, Figs. 9, 10.)

Shells attached: posterior margin straight, set off from the rest of the outline by strong post-lateral indentations. Interior with a thin triangular plate, broad at its base where attached in the cardinal region; supported by a low median septum. Muscular impressions unknown.

Type, *Cardinocrania Indica*, Waagen. (Permo-carboniferous, India.)

Pholidops, Hall. 1859.

(Plate 7, Figs. 14–22.)

Synonyms: *Patellites*, Schlotheim, 1820; *Craniops*, Hall. 1859.

Shells small, patelliform, equivalve, equiconvex, inarticulate, unattached. Outline oval or subelliptical; apex subcentral, excentric or marginal, sometimes terminal and produced. Surface marked by strong concentric, often lamellose lines of growth, which are crowded on the posterior, and distant on the anterior portions of the valves; these are sometimes crossed by faint interrupted radiating lines. On the interior, the surfaces of contact make a broad, smooth, flat or slightly convex border, somewhat broader in front than behind. The muscular and visceral area occupies a sharply defined and very limited space in the apical portion of each valve. In both valves it is of essentially the same size and ovate-triangular in outline, the apex of the triangle pointing forward and usually surrounded by a conspicuous callosity.

The ventral (?) valve bears two well defined central adductors occupying the same relative position as in Crania; these impressions are usually simple, but appear to be sometimes complicated by association with ill-defined scars of the anterior muscles. The posterior adductors or divaricators are situated at the basal angles of the muscular triangle, and are distant from the posterior margin. The linear parietal scars are very strong, the posterior being more or less distinctly lobate, the anterior generally straight or rounding about the central adductors. In the opposite or dorsal (?) valve the scars have essentially the same arrangement; the anterior adductors, however, are separated by elongate median scars (anteriors) which traverse the elevated callosity surrounding the anterior margin of the area. The posterior scars are often more widely divergent than in the other valve. Shell-substance calcareous and impunctate (?).

Type, *Pholidops squamiformis*, Hall.

Distribution, Lower Silurian to Lower Carboniferous.

II.

Brachiopoda Articulata.

Valves articulated; intestine terminating in a blind sac; shell-substance essentially calcareous.

So far as our knowledge of the fossil species extends, there are very few of the forms included in this division to which the above definition does not apply. Several genera show very considerable modification of the articulating apparatus, but with rare exceptions these modifications in each group appear to be progressive, extending along certain lines of development and finally acquiring an extravagant manifestation, which may terminate abruptly or be followed by the degeneration and obsolescence of some of the parts.

For example, the articulating apparatus in Stropheodonta, Productus, etc , may be regarded as in a degenerative condition, and on this account these genera are sometimes placed near the base of the articulate division, though the type of structure exhibited by them is much more highly modified than in Orthis and its immediate allies in the older rocks.

The mode of articulation in Productus appears to have come legitimately from the progress and development of some portions of the articulating apparatus on the one hand, and the obsolescence of other characters, which appear in the earlier forms of strophomenoid shells, and have become modified in their progress through the chonetids. While this may be regarded as a degeneration, it is also a progressive modification.

Of the various designations which have been proposed with a signification equivalent to Professor Huxley's term for this subdivision of the Brachiopoda, are Arthropomata, Owen; Clistenterata, King; while Bronn made use of the two names Testicardines and Apygia.

Orthis, Dalman. 1828.

(Plates 9–12.)

Synonyms; *Hysterolithes*, Schlotheim, 1820; *Orthambonites*, Pander, 1830.

Shell subcircular, subovate or subquadrate in outline. Valves more or less convex, the smaller or brachial valve being sometimes nearly flat or slightly concave. Hinge-line straight and equal to, or shorter than the greatest width of the shell. Cardinal area well developed on each valve and usually divided by an open triangular delthyrium. Beaks more or less incurved. Surface covered by radiating costæ or fine striæ, with faint evidence of median fold and sinus.

In the interior of the pedicle-valve the large hinge-teeth are supported by dental plates which are more or less conspicuously developed, frequently resting upon the bottom of the valve. The bases of these are continued as a low elevation about the muscular area. This muscular impression is divided longitudinally by an inconspicuous median ridge and the larger expansions on each side were probably occupied by the diductor muscles; within these and lying close against the median ridge are the adductors, while the pedicle muscles covered the posterior deltidial portion of this area.

In the interior of the brachial valve the apex of the deltidial cavity bears a more or less developed cardinal process or callosity, which, in the typical group, is elongate and usually simple at its termination. The dental sockets are deep and their inner walls support short divergent crura. The muscular impression is more or less distinctly quadruple, being divided longitudinally by a median ridge extending forward from the cardinal process, and transversely by fainter ridges. This quadruple scar marks the place of attachment of the adductor muscle.

Ramified vascular markings are often retained over the pallial area, the principal trunks diverging from the median region and nearly following the curve of the anterior margin of the shell. Between these and the adductor impressions the markings of the ovarian areas are sometimes visible.

Shell-structure fibrous and impunctate in the typical group.

This extensive genus has been divided into the following groups or subgenera:

Orthis, Dalman, *sensu stricto.*

I. Group of ORTHIS CALLACTIS, Dalman.

(Plate 9, Figs, 1–7.)

Shells plano-convex in contour; costæ, strong, sharp and comparatively few, rarely if ever bifurcating; the cardinal area on the pedicle-valve elevated and somewhat incurved; dental lamellæ slightly developed, not extending the entire length of the umbonal cavity. The cardinal process on the brachial valve is an elongate, vertical plate, extending from the apex the whole length of the delthyrium, thus longitudinally dividing the deep deltidial cavity. It is usually simple, both on the outer edge and at its distal extremity. Shell structure compactly fibrous and impunctate, except for large oblique tubules penetrating the external layers. (Lower — Upper Silurian.)

Plectorthis, Hall. 1892.

II. Group of Orthis plicatella, Hall.

(Plate 9, Figs. 8–10.)

Valves subequally convex. Cardinal area of pedicle-valve low; plications strong, simple or duplicate. Shell substance impunctate. (Lower Silurian — (?) Lower Devonian.)

Dinorthis, Hall. 1892.

III. Group of Orthis pectinella (Conrad, MS.), Emmons.

(Plate 9, Figs. 11–15.)

Relative convexity of the valves reversed. Surface with strong, rarely bifurcating plications. Delthyrium sometimes partially closed. Muscular area in pedicle-valve subquadrate, bounded by extensions of the dental lamellæ. In the brachial valve the muscular impressions are obscure; cardinal process erect, broad and frequently bilobed on its posterior face. Shell structure impunctate. (Lower Silurian.)

Plæsiomys, Hall. 1892.

IV. Group of Orthis subquadrata, Hall.

(Plate 9, Figs. 16–20.)

Valves with reversed convexity. In the interior of the pedicle-valve there is a large quadrate muscular scar, with a tendency to bilobation by the lateral extension of the diductor impressions. The subdivision of this area into separate scars is frequently very distinct. In the brachial valve the cardinal process is thickened and erect at its posterior extremity, being distinctly crenulate on the summit and posterior face. The surface striæ are tubulose and the shell-structure fibrous-impunctate. (Lower Silurian.)

Hebertella, Hall. 1892.

V. Group of Orthis sinuata, Hall.

(Plate 10, Figs. 1–4.)

Shells with convexity of the valves reversed. Surface covered with numerous fine, rounded, closely-crowded plications, crossed by lamellose growth-lines. On the interior of the pedicle-valve the teeth are large and supported by thick lamellæ which are continued as a strong ridge around a short obcordate muscular area. This area is medially divided by a prominent ridge upon the summit of which lies the linear scar of the adductors. The flabellate lateral impressions are sometimes divisible into their two components, diductors and adjustors, and in old individuals the impression of the pedicle-muscle is often distinct.

In the brachial valve the dental sockets are narrow and are inclosed beneath, and on the inner side, by the strong crural plates. The cardinal process is elongate and simple, sometimes thickened, often crenulate, but not lobed at its posterior extremity. The process unites with the inner basis of the crural plates and is produced forward as a median ridge dividing the four muscular scars, which are distinctly developed only in old shells.

Shell-structure fibrous-impunctate; the plications of the surface sometimes tubulose.

(Lower — Upper Silurian.).

Orthostrophia, Hall. 1883.

VI. Group of ORTHIS STROPHOMENOIDES, Hall.

(Plate 10, Figs. 5–8.)

Contour and surface as in HEBERTELLA. In the interior of the pedicle-valve the muscular area is deeply excavated, and limited almost to the narrow space between the dental lamellæ. The adductor scars are extremely minute and linear, while the diductors occupy the rest of the area. In the opposite valve the muscular area is similarly confined but the quadrilobate character of the impression is very decided. The lateral components are divided by a strong median ridge, and the entire area is deeply impressed in the substance of the shell. The cardinal process is elongate and simple at its posterior extremity, the crural plates and crura strong.

The vascular and ovarian markings are conspicuous. In the pedicle-valve two or three large vascular trunks originate near the anterior edge of the muscular area, divide a few times in their passage over the pallial region, the branches rapidly multiplying near the margin. In the opposite valve the main sinuses are four in number, originating in pairs at the ante-lateral margins of the anterior adductors. The outer member of each pair curves quite abruptly toward the cardinal angle, while the inner members curve outward and then inward, all ramifying as they approach the margins of the shell. The umbo-lateral spaces inclosed by the curvature of these sinuses in both valves, and the central space in the brachial valve, are covered with linear dendritic ovarian striæ. Shell substance impunctate.

(Lower Devonian.)

Platystrophia, King. 1850.

VII. Group of Orthis biforata, Schlotheim (sp.).

(Plate 10, Figs. 9-13.)

Contour spiriferoid; hinge-line and area long and straight, nearly equally developed on the two valves. Both valves very convex, the brachial being the more so, and bearing a very strong median fold corresponding to a deep sinus on the opposite valve. Surface of valves marked by strong, sharp plications, which extend over the fold and sinus, and the external surface is finely granulose, the latter feature being rarely well retained. Delthyrium open in both valves, being somewhat larger in the pedicle-valve, and in old and gibbous shells of *Orthis lynx* it has often encroached to a considerable extent upon the umbonal region of the valve. Teeth thick and very prominent; muscular area comparatively small, but usually deeply excavated in the substance of the shell, and not readily divisible into the component scars. The cardinal process of the brachial valve is a simple linear ridge, always small and sometimes nearly obsolete. Dental sockets comparatively small; crural plates large and thick, uniting at their inner bases and produced into a prominent median ridge. Muscular area quadruplicate. Shell-structure very compact and finely fibrous, without punctation.

(Lower — Upper Silurian.)

Heterorthis, Hall. 1892.

VIII. Group of Orthis Clytie, Hall.

(Plate 11, Figs. 1-3.)

Contour leptænoid. Shell transversely oval, with a straight hinge-line and rounded cardinal extremities; its form is depressed plano-convex, the convexity of the pedicle-valve being slight.

The cardinal area is about equally developed on each valve. Surface ornamented by fine, rounded, radiating striæ between each two of which are from two to six much finer radiating lines; all these are crenulated by exceedingly faint growth-lines.

The interior of the pedicle-valve has short teeth with prominent extremities, and inconspicuous dental lamellæ. The muscular impression is large and consists of a small adductor scar situated centrally, and two lateral scars which are flabellate and greatly elongated, but not uniting in front and inclosing the adductor, as is usual in typical forms of Orthis. These lateral scars are divided into subordinate impressions, of which the outer posterior members may represent the adjustors. In the brachial valve the dental sockets are obscure, the crural plates oblique, terminating abruptly at the bases of the crura, their lower part being continued in a low ridge surrounding a short subcircular muscular area, which is very obscurely quadrilobate. The cardinal process has a vertical, sharp, simple, posterior edge, but is much thickened where it unites with the crural plates, and is produced along the muscular area as a prominent median ridge. From the antelateral margins of the muscular area radiate six low, somewhat sinuous ridges of similar character to those frequently seen in members of Group XI. Both valves are considerably thickened just within the margins, as in many strophomenoids.

The shell-structure is finely fibrous and perforated by minute punctations which are in general sparsely developed, but most distinctly arranged in radiating rows corresponding to the surface striæ.

(Lower Silurian.)

Bilobites, Linné. 1775.

Synonym: *Dicœlosia*, King. 1850.

IX. Group of Orthis biloba, Linné.

(Plate 10, Figs. 14–19.)

Shells small, strongly bilobed. Hinge-line short; teeth and sockets obscure; cardinal process small and simple. Crural plates thin and very long, often extending as far forward as the commencement of the lobation. Muscular area indistinct, larger in the brachial, than in the pedicle-valve. Shell-substance fibrous and punctated by coarse tubules apparently arranged in radiating rows.

(Lower Silurian — Lower Devonian.)

Dalmanella, Hall. 1892.

Group of Orthis testudinaria, Dalman.

(Plate 11, Figs. 4–17.)

Shells plano-convex or subequally biconvex. Pedicle-valve usually the deeper, often gibbous, elevated at the umbo and arched over the cardinal area. Hinge-line generally shorter than the greatest width of the shell. In many of the species there is a more or less conspicuous, undefined median fold and sinus on the pedicle and brachial valves respectively. Surface covered with fine, rounded bifurcating striæ.

In the pedicle-valve the teeth are quite prominent, thickened at their extremities and supported by lamellæ which are produced forward, circumscribing a rather short suboval or subquadrate muscular area, which is more or less distinctly defined in different species and in different conditions of the shell.

In the brachial valve the cardinal process extends forward to the bases of the crural plates, where it is broadened and continued thence as a median ridge separating the muscular impressions. The inner surface of this process is divided by a faint median furrow which produces two lobes at the posterior extremity, and each of these lobes is again divided, making the process quadrilobate. Sometimes the inner divisions of the two main lobes have coalesced, producing a strong median lobe and thus making the process appear trilobate. In some species, at maturity, and in others from abnormal growth, this process becomes a broad plug, which fills the entire delthyrial opening. The dental sockets are small, the crural plates often greatly elevated, especially in the plano-convex forms, and they are not usually produced into a ridge about the muscular area, but end abruptly. Muscular impressions quadruplicate, sometimes with radiating ridges extending from the lateral and anterior margins.

Shell-substance finely fibrous and punctate.

(Lower Silurian — Upper Silurian.)

Rhipidomella, Œhlert. 1890.

Synonym; *Rhipidomys*, Œhlert. 1887.

XI. Group of ORTHIS MICHELINI, Léveillé.

Plate 12, Figs. 1–13.)

Shell subcircular in outline, biconvex and sublenticular, with the brachial valve somewhat the deeper. Hinge-line short, cardinal area narrow, especially on the brachial valve. The surface bears a slight median depression on each valve, and is covered with fine, rounded, subequal striæ which are hollow, often opening upon the surface; these openings probably represent the broken bases of short tubular spines.

The pedicle-valve bears two strong diverging teeth, planted firmly upon the valve at the bottom of the delthyrium, and extending upward and outward at their extremities; from their bases a more or less strongly defined curving ridge extends forward, bordering the muscular area. The muscular area extends from one-third to five-sixths the length of the valve and is deeply impressed; the pedicle-scar fills the entire rostral cavity; the adductors occupy a small central scar which is completely enveloped by the great diductors. A median ridge arises in front of the adductors, dividing the diductors; sometimes the latter scars rest upon a general anterior flattening of this ridge, and in rare instances the ridge divides the separate components of the adductor impression. The margin of the entire muscular area is thickened and elevated, and outside of this are deeply pitted ovarian markings.

In the brachial valve the dental sockets are deep and narrow, the crural plates extremely prominent, sometimes supporting short crura. The cardinal process is erect, strongly arched on its anterior face, often very thick and greatly elevated; the edge of its posterior face is multilobate, the posterior surface itself having a trilobed appearance. The muscular area is quadruplicate, comparatively small and usually indistinct. A broad, low, median ridge extends forward from the base of the cardinal process. The shell-structure is coarsely fibrous and very strongly punctate, the perforations being large and generally more abundant along the furrows between the striæ.

(Upper Silurian — Upper Carboniferous.)

Schizophoria, King. 1850.

XII. Group of ORTHIS RESUPINATA. Martin.

(Plate 11, Figs. 18–23.)

Shells resupinate or with normal convexity reversed as in Groups IV, V, VI. Surface very finely striate, the striæ being hollow, tubulose and produced into short spines as in RHIPIDOMELLA.

In the pedicle-valve there is a short subquadrate or obcordate muscular area with thickened, elevated margins, and deeply sunk in the substance of the shell; in the opposite valve a less distinctly defined, quadripartite area. In the brachial valve the crural plates are erect and divergent; the cardinal process, which in young shells, has much the same character as in RHIPIDOMELLA, becomes resorbed and thus narrowed with age, making a thin and sharp ridge; concomitant with this change is the formation, in the delthyrial cavity, of one, two or even three minor ridges on each side of the original process, so that in old shells the posterior face of the process appears to be multilobate. In this valve four (rarely six) deep pallial sinuses take their origin at the anterior margin of the muscular area, passing forward as broad, simple, subparallel bands, to near the margin of the valve, where they bifurcate and become arborescent. Shell substance highly punctate.

(Upper Silurian—Coal Measures.)

Orthotichia, Hall. 1892.

XIII. Group of ORTHIS ? MORGANIANA, Derby.

(Plate 12, Figs. 14–17.)

External form as in SCHIZOPHORIA. In the pedicle-valve the dental lamellæ are highly developed, between them lying a conspicuous median septum; muscular area not deeply impressed. Shell substance punctate.

(Carboniferous; Brazil, India.)

Enteletes, Fischer de Waldheim. 1830.

XIV. Group of *Enteletes Lamarcki*, Fischer de Waldheim.

(Plate 12, Figs. 18–21.)

Valves strongly inflated; brachial valve the more convex. Surface coarsely ribbed and covered with fine radial striæ. Hinge-line short; cardinal area of pedicle-valve highly developed. On the interior the pedicle-valve bears strong teeth, highly developed convergent dental lamellæ, and an elevated median septum which extends to the middle of the valve, terminating abruptly. In the brachial valve the crura are recurved over the cardinal line and are supported by strong septa; cardinal process small, erect and multilobate. Muscular scars very faint. Shell substance punctate, tubulose at the surface.

(Carboniferous.)

Billingsella, Hall. 1892.

(Plate 8, Figs. 1, 2.)

Shell transverse; subquadrate or semicircular in outline. Contour concavo—, or plano-convex. Surface sharply striate or plicate. Pedicle-valve the more convex; cardinal area moderately high, vertical or slightly incurved. Delthyrium covered by a convex plate, which, in rare instances, may be minutely perforated at the apex; the teeth are well developed, but the dental plates are continued along the bottom of the umbonal cavity, only near the apex inclosing a small subelliptical muscular area. In the brachial valve the cardinal area is greatly inclined, making an obtuse angle with that of the opposite valve. The delthyrium is partially covered by a convex deltidium which never attains the development seen in the opposite valve, and is often wholly absent.

Type, *Orthis Pepina*, Hall.

Distribution. Cambrian—(?) Upper Silurian.

Protorthis, Hall. 1892.

(Plate 8, Figs 3–7.)

Shells small, transversely subquadrate or semicircular. Hinge-line straight, its length being equal to the greatest width of the valves. Valves unequally biconvex, or sub-planoconvex, the pedicle-valve being the larger. The cardinal area is narrow on both valves, but is higher on the pedicle-valve, and is transected by a broad delthyrium which is closed below by a concave plate apparently produced by the union of the dental lamellæ, which are not continued to the bottom of the valve; teeth distinctly developed. In the brachial valve the cardinal area also bears an open delthyrium; the dental sockets are obscure and the crural plates small; the latter appear to unite and form a low elevation across the base of the delthyrium. Cardinal process absent or rudimentary in all the specimens examined.. Muscular markings in both valves extremely obscure.

Surface marked by distinct plications, with interstitial finer radii, which are crossed by delicate concentric striæ; these are usually accompanied by a low sinus and fold on the brachial and pedicle-valves, respectively; interior very finely papillose. Shell-substance fibrous and apparently punctate.

Type, *Orthis Billingsi*, Hartt. (Cambrian.)

Clitambonites, Pander. 1830.

(Plate 8, Figs. 8, 9.)

Synonyms; *Pronites*, *Gonambonites*, Pander. 1830.

Shells with a subsemicircular marginal outline; convex or subpyramidal in the typical group. Hinge-line straight and forming the greatest diameter of the shell. Pedicle-valve elevated, cardinal area high, vertical, or sometimes incurved, and crossed by a broad delthyrium, which is normally covered by a convex, perforate deltidium. On the interior of the valve the dental lamellæ are very strongly developed, converging and uniting in the median line before reaching the bottom of the valve; thus forming a spondylium, which, with the deltidium, incloses a conical subrostral vault. This plate is supported by a median septum extending for about one-half the length of the valve. Muscular impressions obscure. In the brachial valve the cardinal area is considerably developed, and the delthyrium filled by a conspicuous callosity, against the inner side of which the simple orthoid cardinal process abuts. The dental sockets are large, the crural plates low and continuous with the edges of the delthyrial callosity. A thickened transverse area is formed in the umbonal region by the union of the inner portions of the crural plates with the cardinal process, and thence a broad median ridge is continued forward through the muscular area, which is sharply defined and quadripartite. External surface covered with radiating striæ. Shell-substance impunctate.

Type, *Clitambonites adscendens*, Pander.

Distribution. Lower Silurian.

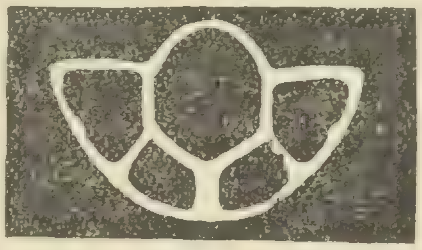
Hemipronites, Pander, 1830. (Plate 8, Figs. 14, 15.) Shells as in Clitambonites but with shorter hinge-line and subequally convex valves. Type, *H. tumida*, Pander; Lower Silurian).

Orthisina D'Orbigny, 1847. (Plate 8, Figs 10–13.) Shells as in Clitambonites but with the cardinal area and chilidium of the brachial valve extravagantly developed. Type, *O. anomala*, Schlotheim (sp.) Lower Silurian).

Subgenus **Polytœchia**, Hall. 1892.

(Plate 8, Figs. 16–20.)

Shell small, subtrihedral in contour. Hinge-line straight, about equaling the diameter of the shell. Pedicle-valve with a high, nearly vertical cardinal area marked with oblique striations parallel to the lateral margins. Delthyrium covered by a narrow, convex plate; the presence of a foramen not determined. On the interior the dental lamellæ are widely separated, and descend along the umbonal cavity for a short distance vertically, thence bending sharply inward and meeting at a low angle in the median line; thus forming, with the deltidium, a conspicuous subrostral vault. This is supported by a stout median septum, and two smaller lateral septa, which meet it at the lines of angulation; the former of these extends for the entire length of the plate, while the latter is free from the accessory septa near its anterior edge. The umbonal cavity of the valve is thus divided into five chambers, and in the lateral chambers there is still another septum, lower than the rest and not extending to the spondylium. The brachial valve is shallow and depressed-convex, with a narrow cardinal area. The delthyrium is very broad with a partially developed covering, the dental sockets are widely separated, the crural plates narrow and nearly parallel to to the hinge-line. The cardinal process is simple, linear and quite prominent, and at its union with the crural plates is a subtriangular thickening which is supported by a low median septum. Surface covered with fine, elevated, radiating striæ, without evidence of median fold and sinus.



Polytœchia apicalis.
Fig. 269.—Transverse section of pedicle-valve, near the apex.

Type, *Hemipronites apicalis*, Whitfield.
(Lower Silurian.)

Scenidium, Hall. 1860.

(Plate 8, Figs. 21–27.)

Synonym; *Mystrophora*, Kayser, 1871.

Shell subpyramidal, somewhat semicircular, with or without median sinus and elevation. Pedicle-valve elevated, subpyramidal; beak straight or slightly arched; muscular impressions undetermined. Cardinal area large, triangular, divided by a narrow fissure, which is sometimes closed at the summit by a concave plate. Brachial valve flat, or varying from depressed-convex to concave. Beak entire, or indented by the foramen; cardinal line straight and usually equaling the width of the shell; crural plates broad and well developed, marked by the imprints of the pedicle muscles, and produced in the middle in a pointed process; the cardinal process extends, as a median septum, through the length of the shell, and may be simple or divided at its anterior extremity. Exterior surface covered with radiating striæ.

Type, *Scenidium insigne*, Hall.

Distribution. Lower Silurian — Middle Devonian.

Orthidium, Hall. 1892.

(Plate 8, Figs. 28–31.)

Shell very small, transverse, having the external aspect of SCENIDIUM. Hinge-line long, making the greatest diameter of the shell. Pedicle-valve the more convex; cardinal area moderately high, with a broad open delthyrium, strong teeth and inconspicuous dental plates; in all respects like the corresponding valve of *Orthis calligramma*. Brachial valve slightly convex; cardinal area very narrow; dental sockets well developed, crural plates very short and erect, coalesced with the cardinal process, which thus becomes a vertical, transverse, subcrescentic plate, at the base of which the shell is somewhat excavated; muscular scar quadruplicate. Surface covered with radiating striæ, which extend over the broad, low sinus and fold in the brachial and pedicle-valves respectively. In the former the sinus makes a prominent median ridge in the interior of the valve. Shell-structure not determined.

Type, *Orthidium gemmicula*, Billings.

(Lower Silurian.)

Leptella, Hall. 1892.

(Plate 13, Figs. 10–12.)

Shells small, normally concavo-convex. Outline semicircular or semielliptical. Hinge-line straight, making the greatest diameter of the shell. Pedicle-valve evenly convex, cardinal area moderately high, delthyrium for most of its extent covered by a convex plate; teeth inconspicuous and unsupported by lamellæ; muscular impressions undetermined. Brachial valve slightly concave; cardinal area comparatively high; the delthyrium filled by the cardinal process, which, as viewed from behind, is divided by a median groove for its entire height. On the cardinal margin this process is double but less conspicuous than the crural plates, which are arched and highly elevated above the hinge-line. They are short, terminate abruptly, and inclose deep sockets. The visceral area is flattened or concave, its anterior margin forming a double curve, from which line the surface of the valve is abruptly deflected. This visceral area is divided by a broad median ridge and its surface covered with fine, sharp radiating lines which end at the line of deflection.

Type, *Leptella sordida*, Billings.

Distribution. Cambrian — Lower Silurian.

Leptæna, Dalman. 1828.

(Plate 13, Figs. 1–4, 6–9.)

Synonym; *Leptagonia*, McCoy, 1844.

Shells plano-convex when young, concavo-convex at maturity; convexity normal. Surface covered by conspicuous concentric corrugations or wrinkles over the flatter portions of the valves. Where these cease the surface is more or less abruptly and often rectangularly deflected, forming a conspicuous anterior slope. The whole exterior is covered with fine, even, radiating, thread-like, tubular striæ, which, in well-preserved specimens, are crenulated by finer concentric striæ. Outline transversely subquadrate or semioval. Hinge-line straight, its length making the greatest diameter of the shell; extremities often subauriculate. Cardinal area narrow, slightly wider on the pedicle-valve, not denticulate. In the pedicle-valve, the delthyrium is covered by a convex deltidium, perforated at the apex by a foramen which is closed at maturity or encroaches upon the apex of the valve.

This deltidium is most conspicuously developed in early stages of growth, when it has the form of a tube or sheath, which character becomes obliterated as maturity approaches, by the increase in the size of the cardinal process, and the deltidial callosity formed about its base. In adult shells the foramen has become inclosed by the substance of the shell, its external opening being an oblique groove in front of the apex of the valve, and its inner aperture appearing in front of the pedicle-scar. Not infrequently the passage is closed at maturity. The teeth are very divergent and quite conspicuous, generally supported by lamellæ which are continued around the subcircular muscular area of the narrow umbonal cavity. The muscular scars consist of a narrow median or adductor, inclosed by flabelliform diductors.

In the brachial valve the area is linear, the delthyrium is progressively filled by the growth of a callosity, which is often deeply grooved, along the center, and sometimes perforated in the line of division between the branches of the cardinal process. The cardinal process consists of two sessile, diverging apophyses which have broad, flat, striated surfaces of attachment, and are extended beyond the hinge-line. The sockets are moderately deep; the crural plates are usually not sharply defined, but are continued in a curving line along the inner surface of the valve, partially embracing a pair of broad, ovate muscular impressions which are marked by aborescent ramifications; recurving and again incurving, these ridges partially surround a pair of smaller muscular areas, lying in front of the first. At the inner base of each branch of the cardinal process there arises a low elevation or callosity, which, extending obliquely forward, and uniting in the center, continues as a narrow median ridge dividing the posterior pair of muscular impressions. This ridge sometimes terminates in a point near the base of the first pair of impressions, and the second pair are separated by a low, slender median septum, which sometimes apparently takes its origin at this point, but which is in fact a continuation from the interrupted posterior ridge, and extends for some distance over the pallial region.

The muscular area, when its features are most distinctly retained, shows the subdivision into the following scars: (*a*) A large posterior pair (the posterior adductors), the surface of which is covered with arborescent ridges; the anterior portion of each of these scars is smoother than the rest, generally much thickened and often extremely elevated at its outer margins. These may be regarded as accessory elements of the posterior adductors. (*b*) An anterior pair (anterior adductors), situated close together at about the center of the valve. The position of these is generally well defined but their outline is frequently obscure. (*c*) An elongate, narrow median scar, which is apparently divided for its entire length by a faint ridge. In front of the muscular area there are often a number of short protuberances on each side of the median septum, and the anterior pair of scars is frequently obliterated by prominent callosities. At the line of geniculation the interior surface is elevated into a very prominent, sharp, or abruptly rounded crest. Spiral callosities for the support of the brachia, similar to those in DAVIDSONIA and LEPTÆNISCA, have been observed.

Shell-substance strongly punctate.

Type, *Leptæna rugosa*, Dalman.

Distribution. Silurian — Carboniferous.

Rafinesquina, Hall. 1892.

(Plate 13, Figs. 513-18.)

Shells normally concavo-convex. Surface ornamented by radiating striæ, of alternating size, crossed and crenulated by finer concentric striæ. Cardinal margins without denticulations. Interior of the pedicle-valve with the muscular area not strongly limited; consisting of two broad flabellate diductor scars inclosing an elongate, more distinctly defined adductor. The faintness of the limitation of this area is in marked contrast to the sharply defined muscular area in the corresponding valve of LEPTÆNA. In the brachial valve the cardinal process is more closely sessile than in LEPTÆNA, and there is frequently a linear callosity between the branches. The posterior adductor scars have the arborescent markings of *Leptæna rhomboidalis*, and these impressions are the only ones well defined, the anterior scars being narrow and rarely retained with distinctness. From the anterior margin of the muscular area radiates a series of irregular furrows and nodose ridges, which are to some extent of vascular origin.

Type, *Rafinesquina alternata*, Conrad (sp.).

Distribution. Lower — (?) Upper Silurian.

Stropheodonta, Hall. 1852.

(Plate 14, Figs. 1–6.)

Shells normally concavo-convex. Cardinal area common to the two valves, that of the brachial valve narrower or linear; smooth or finely striated longitudinally, sometimes showing through the outer laminæ of the shell, strong, parallel, transverse bars, which project beyond the cardinal margin as short processes, and articulate with a corresponding series of pits in the opposite valve. The earliest species have these denticulations developed only for a short distance on each side of the center, while in the latter faunas they extend the entire length of the hinge-line. In the type-species the delthyrium is usually completely closed by the extension of the shelly laminæ of the area, and on the inside by the formation of a callosity between the apophyses of the cardinal process. Sometimes a low, narrow, convex deltidium is present, and in the early species the delthyrium is frequently open.

From the normal position of the dental lamellæ there extend two diverging, sometimes nearly vertical ridges of variable strength bounding the post-lateral portion of the muscular area, which is not limited by a ridge in front. The entire muscular area consists of two broad flabelliform diductor scars, inclosing an oval adductor which is distinctly divided into anterior and posterior elements. The foramen, dental plates and teeth are obsolete or obsolescent in the Devonian species.

In the brachial valve the delthyrium is also usually closed, the cardinal apophyses are strongly arched into the umbonal cavity of the opposite valve, their surfaces of attachment being sometimes nearly parallel to the plane of the cardinal area of the brachial valve, and often extending beyond it. Small crural plates are always present, though they could not have been functional at maturity. Muscular arrangement similar to that of *Rafinesquina alternata*, the posterior scars being more elongate the anterior pair usually less defined, and all the scars frequently obscured. The anterior muscular fulcra are sometimes developed into very prominent elongate apophyses. The median septum often becomes elevated into a high crest at the center of the valve. Over the pallial region the interior of both valves is strongly papillose. External surface covered with radiating, sometimes fasciculate striæ; rarely smooth. Shell-substance fibrous, coarsely punctate.

Type, *Stropheodonta demissa*, Conrad (sp.).

Distribution. Lower Silurian (?) — Upper Devonian.

Subgenus **Pholidostrophia,** Hall. 1892.

(Plate 14, Figs. 11–15.)

Shells small; surface smooth or squamous; nacreous. Interior of the brachial valve with three diverging ridges in front of the muscular area. (Type, *P. nacrea*, Hall (sp.). Devonian.)

Subgenus **Leptostrophia,** Hall. 1892.

(Plate 15, Figs. 1–4.)

Shell plano-convex or flat; delthyrium more or less completely closed. In the pedicle-valve are two pustulose diverging ridges, bounding the sides of the muscular area. Cardinal scars broad and flabellate; not distinctly limited anteriorly. (Type, *L. magnifica*, Hall. Devonian.)

(?) Subgenus **Brachyprion,** Shaler. 1865.

(Plate 14, Figs. 7–10.)

Shells with delthyrium open or partially covered; crenulations of the cardinal margin confined to a very limited extent on either side of the fissure.

(Type, *B. Leda*, Billings (sp.). Upper Silurian.)

Subgenus **Douvillina,** Œhlert. 1887.

(Plate 14, Figs. 16–19.)

Shells having a crenulated hinge and flat deltidium. In the pedicle-valve are two small teeth connected with diverging ridges which are strongly elevated in front, and inclose a transverse muscular area. Beneath the beak are two crests supported by a short median septum; posteriorly these all unite to form a single apophysis grooved in the middle and uniting with the inner surface of the deltidium. The brachial valve has a prominent bifid cardinal process, and a pair of small protuberances representing the crural plates; from the base of the cardinal process extends a median

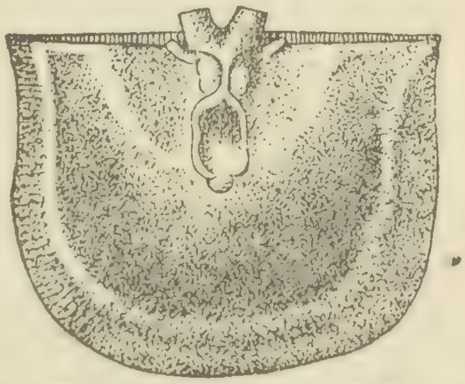
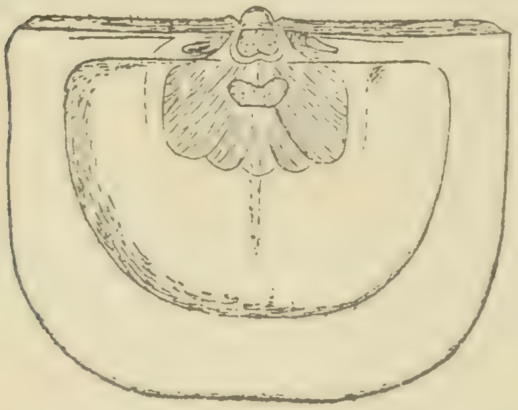


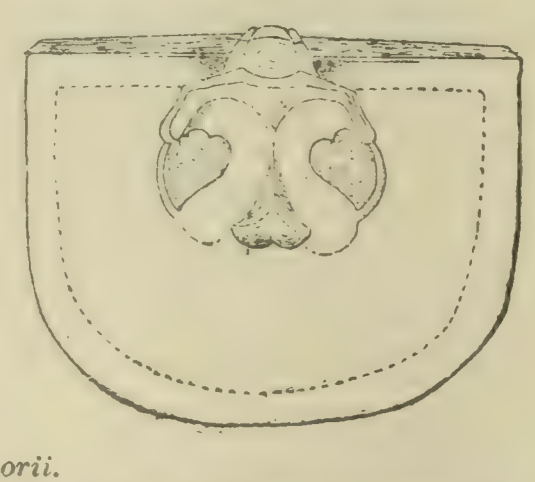
FIG. 270.—Brachial valve of *Douvillina Dutertrii*. After ŒHLERT.

ridge which bifurcates anteriorly inclosing a cavity for the insertion of the anterior adductors. (Type, *D. Dutertrii*, Murchison (sp.). Devonian.)

Cadomella, Munier-Chalmas. 1887.

Shell nearly flat or gently concavo-convex; hinge-line long, straight; beak of pedicle-valve scarcely prominent; cardinal areas linear; deltidium narrow. On the interior the pedicle-valve bears divergent teeth between which lies an apophysis, serving as a base of attachment for the accessory diductors. The principal diductor scars are flabellate, but do not extend beyond the umbonal region. In the brachial valve is a stout cardinal process, grooved upon its upper surface near the lateral margins. Socket-walls greatly elevated and continued into curved crural apophyses which have a tendency to become free toward their extremities. There is a median septum which, at its anterior end, at the center of the valve, is strongly elevated and bilobed. The four adductor impressions united into two cordate scars whose outer margins are strongly thickened.





Cadomella Moorii.

Fig. 271.—Interior of pedicle-valve.

Fig. 272.—Interior of brachial valve. (Munier-Chalmas.)

Type, *Cadomella Moorii*, Davidson (Lias).

Strophonella, Hall. 1879.

(Plate 15, Figs. 5–11.)

Shells semicircular or semielliptical, concavo-convex, resupinate, the pedicle-valve concave and the brachial valve convex. Area of pedicle-valve striated, solid, with or without a centradeltidial scar, or rarely a partial foramen, with similar features on the narrow area of the brachial valve; inner margins of the cardinal areas of each valve crenulate, and from beneath the center of the ventral area there is often a strong process (frequently bilobed) which extends beyond the cardinal line. Muscular area of the pedicle-valve strongly marked, and limited by a prominent border. Brachial valve wlth a narrow hinge-area transversely or longitudinally striate, or both, and marked in the center by a deltidial scar. Cardinal process double, each division notched or bidentate at the extremity; muscular areas quadrangular.

Type, *Strophonella fasciata*, Hall.

Distribution. Upper Silurian — Upper Devonian.

Subgenus **Amphistrophia**, Hall. 1892.

(Plate 15, Figs. 12–14.)

Shells with convex deltidium and very short row of cardinal denticulations. In the pedicle-valve the muscular area is not inclosed; in the brachial valve muscular markings extremely faint.

(Type, *A. striata*, Hall (sp.). Upper Silurian.)

Strophomena, Rafinesque (de Blainville). 1825.

(Plate 14, Figs. 1–7.)

Synonyms; (?) *Strophomenes*, Rafinesque, 1820, 1831; Defrance, 1824.

Shells transversely subsemicircular or semielliptical; greatest width along the hinge-line. Surface concavo-convex and covered with fine radiating striæ which are equal or alternate in size. The pedicle-valve is slightly convex about the umbo, but becomes rapidly concave toward the middle with the apex perforated, except in old age. The cardinal area is conspicuous and nearly vertical, and the delthyrium closed by a convex plate or deltidium. Teeth widely divergent and supported by plates which are produced into elevated ridges nearly surrounding the muscular area. The latter is relatively short, subcircular in outline, deeply excavated and divided medially by a more or less distinctly defined longitudinal ridge which is often continued over the pallial region.

The brachial valve is concave at the umbo, becoming strongly convex with growth; it has much the narrower cardinal area, and the delthyrium is rudimentary or incomplete. Dental sockets deep, and continued as narrow grooves or indentations across the cardinal area. The crural plates are extended laterally with a slight curve, but are not supported by septa; at their inner margins they unite to form a callosity, upon which rests the short, bilobed cardinal process, which scarcely extends beyond the hinge-line. The muscular surface of this process is cordate in outline and is placed at a low angle to the plane of the area. A low median ridge extends forward from the hinge-plate separating two large adductor scars, in front of which are two narrow elongate impressions. Vascular and ovarian markings frequently well defined. Shell-substance fibrous, strongly punctate.

Figs. 273, 274.—*Strophomena rugosa*. After de Blainville.

Type, *Strophomena rugosa* Rafinesque (de Blainville), 1825,= *Leptœna planumbona*, Hall, 1847, as recognized by King and other authors.

Distribution, Lower —(?) Upper Silurian.

Orthothetes, Fischer de Waldheim. 1830.

(Plate 14, Figs. 8–16.)

Shells plano-convex or biconvex, sometimes becoming concavo-convex with age. Brachial valve usually the deeper in the pallial region; pedicle-valve highest about the umbo, which is sometimes much extended, and often shows a pronounced tendency to irregular growth. Surface covered with slender, subequal radii, which are crenulated by sharp concentric striæ. Hinge-line long, equaling, and often greater than the width of the shell; in some species frequently showing a tendency to auriculation at the extremities. Pedicle-valve with the cardinal area prominently developed; the delthyrium covered by a thick, more or less convex deltidium, which is rarely if ever perforated at maturity. On the interior the teeth are moderately large, sometimes thickened, but not supported by dental plates. The muscular area is marked by flabelliform cardinal scars, inclosing a small adductor impression.

In the brachial valve the cardinal area is narrow, the deltidial covering small and emarginate at the center. The cardinal process is united to the crural plates, the whole forming a vertical subcrescentic process, most elevated centrally and notched or divided at its crest, making it bilobed or bidentate, as seen from its inner surface ; on its outer or posterior face each apophysis is deeply grooved, giving the entire cardinal process, from this point of view, a distinctly quadrilobate appearance. The crural plates end more or less abruptly in elevated points, which undoubtedly mark the place of attachment of the crura. The bases of these plates are not produced around the muscular area. Muscular impression flabelliform, very much as in the other valve; divided medially by a low faint ridge. Shell-substance strongly punctate.

Type, *Orthothetes crenistria*, Phillips (sp.).

Distribution. Upper Silurian — Carboniferous.

Hipparionyx, Vanuxem. 1842.

(Plate 14, Figs. 17–20.)

Shell large, subhemispherical. In youth, the pedicle-valve is very slightly convex, but at maturity it is depressed, or concave, over the pallial region. The brachial valve is always very convex. Marginal outline of the valve subcircular. On the pedicle-valve the hinge-line is straight but short, the cardinal area low, and the beak retrorse. The delthyrium is broad, and covered by an imperforate convex deltidium. The teeth are moderately large and are supported by lamellæ which extend to the bottom of the umbonal cavity, and are produced into strong ridges entirely surrounding the muscular area. This area is very large and is composed of broad, flabellate diductors inclosing an elongate or cordate adductor impression. There is a low median septum in the umbonal cavity, separating the arms of the cardinal process of the opposite valve, but it is quite short, disappearing at the adductor scar, though sometimes reappearing in front of it.

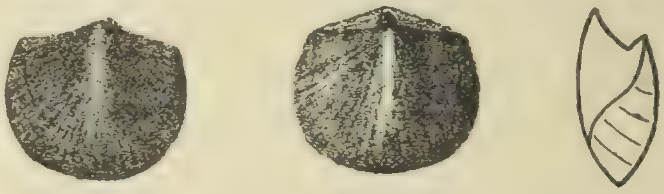
In the brachial valve there is no cardinal area. The cardinal process has essentially the same structure as in ORTHOTHETES and DERBYA, but is very high, its two branches completely traversing the umbonal cavity of the opposite valve; it is supported by a short, median septum, and laterally by strong crural plates which extend for a short distance along the margins of the muscular impressions; these are usually quite faint and undefined, occupying a much smaller area than in the pedicle-valve, and leaving arborescent markings as in some species of STROPHEODONTA. On the interior of both valves the margin is sharply pectinated, or crenulated, the crenulations on the brachial valve extending to the base of the cardinal process, and in the pedicle-valve extending for a considerable distance on the cardinal area. Surface of both valves covered with fine sharp radiating striæ. Shell substance punctate.

Type, *Hipparionyx proximus*, Vanuxem.

Distribution. Lower Devonian (Oriskany sandstone; but a single species is known).

Kayserella, Hall. 1892.

Shell subsemicircular; hinge-line nearly equaling in length the greatest width of the shell; convexity normal. Pedicle-valve more convex than the brachial; area moderately high; delthyrium covered by a convex plate. Brachial valve slightly convex; area narrow; chilidium well developed. In the interior, a large triangular median septum extends almost to the bottom of the opposite valve. Surface with a slight median ridge and furrow on pedicle and brachial valves respectively; covered with sharp plications, increasing by intercalation near the margin. Shell substance punctate.



FIGS. 275, 276, 277.—*Kayserella lepida*. After KAYSER.

Type, *Kayserella lepida*, Schnur (sp.).

Distribution. Middle Devonian (Eifel; but a single species is known).

Derbya, Waagen. 1884.

(Plate 17, Figs. 1–9.)

General character of the shell as in ORTHOTHETES. The external form is more variable, being usually plano-convex, sometimes concavo-convex, the pedicle-valve often the more elevated and subpyramidal, becoming irregular in its growth toward the apex. The interior of the pedicle-valve bears a high median septum, extending longitudinally through the center of the muscular area, which is from one-third to two-thirds the length of the valve; near the apex of the umbonal cavity it unites with the dental plates forming a small triangular chamber beneath the deltidumi. In old shells this cavity is often filled by testaceous secretion. The dental plates do not extend to the bottom of the rostral cavity except near the apex.

Brachial valve broad and regularly convex, or sometimes with an undefined median depression, and showing a tendency to auriculation at the cardinal extremities. Cardinal area linear; the crural plates are abruptly elevated, and unite to form a strong, erect cardinal process, which is distinctly bilobed at the summit; each lobe being slightly notched at the summit and distinctly grooved along the posterior face, these grooves uniting in a wider one at the posterior base of the process. Midway in their length these crural plates are marked by a transverse ridge which terminates on their anterior face in points for the attachment of the crura; on the inside of the dental sockets there is a distinct, sometimes strongly defined ridge, extending along the lateral margin of the broad flabelliform muscular area, and gradually becoming obsolete. There is also a slight median ridge which becomes obsolete below the middle of the muscular area. Surface marked by strong, sharply elevated radii, which alternate with finer ones, all being crenulated, and the intermediate space cancellated by fine concentric striæ.

Type, *Derbya regularis*, Waagen.

Distribution. Carboniferous.

Meekella, White and St. John. 1868.

(Plate 17, Figs. 10–13.)

Shell robust, biconvex, often subpyramidal. Hinge-line straight and shorter than the greatest width of the shell. On the pedicle-valve the cardinal area is often greatly elevated and distorted; the delthyrium is covered; the convex portion of the deltidium being much narrower than the space between the dental ridges. In the interior the teeth are prominent and supported by septiform dental lamellæ which reach the bottom of the umbonal cavity and extend forward for one-third or one-half the length of the shell. The brachial valve has a full, gibbous umbo, and a rudimentary or linear cardinal area. On the interior are two divergent lamellæ or crural plates, which are extended forward for more than one-third the length of the valve, supporting a high, erect cardinal process, which sometimes reaches almost to the apex of the umbonal cavity in the opposite valve. This process is a somewhat curved, thin, crescentic plate, bearing on its summit two slender median apophyses, below which are two stouter lateral projections having the form of extended, rounded lobes, which form the bases of the crura. Surface of the valves marked with coarse costæ, which, with the interspaces, are covered by fine radiating, often plumose, striæ. Shell-substance fibrous, punctate.

Type, *Meekella striatocostata*, Cox (sp.).

Distribution. Upper Carboniferous.

Streptorhynchus, King. 1850.

(Plate 17, Figs. 14–18.)

Shells somewhat trihedral and subpyramidal, with base convex; hinge-line shorter than the greatest width of the valves. Pedicle valve having the beak acute and often incurved and distorted. Cardinal area high, somewhat incurved; delthyrium covered by a broad imperforate, depressed-convex deltidium. The interior of the valve with low dental ridges terminating in teeth of moderate size; these ridges are not septiform and do not continue to the bottom of the umbonal cavity; there is no median septum; muscular scars strong and flabelliform.

In the brachial valve the cardinal area is linear, the crural plates are vertical and abruptly elevated on their anterior edges, forming points of attachment for the crura; these unite to form a subcrescentic plate, from the center of which arises a broad, erect, cardinal process, which is deeply divided into two lobes, each of which is faintly grooved at its summit and on the posterior face; muscular area small, divided medially by a low ridge. Exterior surface covered by fine radiating striæ.

Type, *Streptorhynchus pelargonatus*, Schlotheim (sp.).

Distribution. Carboniferous (?) — Permian.

Triplecia, Hall. 1858.

(Plate 18, Figs. 1–15.)

Synonym; *Dicraniscus*, *Meek*, 1872.

Shell trilobate, transverse, unequally biconvex. Hinge-line straight and quite short. Pedicle-valve shallow, convex about the beak, but depressed anteriorly by a broad and deep median sinus; cardinal area low, erect and well defined; delthyrium covered by a narrow, convex plate, with a circular foramen at the apex. In the interior the teeth are well developed and supported by short dental lamellæ longitudinally dividing the umbonal cavity near its apex. Muscular area small, comprising two lateral scars, separated by a longer central adductor impression. The brachial-valve is very convex, and bears a strong median fold. The cardinal area is very narrow and the beak closely incurved. In the interior is a long, erect and bifurcate cardinal process, the distal extremity of each branch bearing a single deep groove. This process is supported on a subrostral callosity, which also bears two short spiniform crural points at its base. Shell-substance fibrous, impunctate (?). Surface with obscure concentric growth-lines, and fine radiating striæ on the inner laminæ; in rare instances there are radiating lines on the exterior.

Type, *Triplecia extans*, Emmons, (sp.)

Distribution. Lower — upper Silurian.

Mimulus, Barrande. 1879.

(Plate 18, Figs. 16–19.)

Contour trilobate as in Triplecia median fold on the pedicle-valve in the typical species. Shells sometimes bilaterally unsymmetrical. Cardinal area of the pedicle-valve smooth, with but little if any external evidence of deltidium. Teeth small, not supported by dental lamellæ. Brachial valve with an erect, deeply bifurcated cardinal process.

Type, *Mimulus perversus*, Barrande.

Distribution. Upper Silurian.

Streptis, Davidson. 1881.

(Plate 18, Figs. 20–22.)

Shells biconvex, bilaterally unsymmetrical; divided medially by a sinus. Pedicle-valve with a well-defined cardinal area and o ramen. Teeth small, supported by short dental plates. Brachial valve with an erect, probably bifurcated cardinal process. External surface covered with lamellar expansions at the concentric growth-lines.

Type, *Streptis Grayi*, Davidson.

Distribution. Upper Silurian (England and Bohemia).

Plectambonites, Pander. 1830.

(Plate 19, Figs. 1–7.)

Shells usually small, normally concavo-convex. Surface covered with very fine striæ, often alternating in size. Hinge-line making the greatest width of the shell, the extremities often subauriculate. Cardinal area narrow in both valves, sometimes obscurely crenulated on the margins. Pedicle-valve with a moderately broad delthyrium which is partially closed by a convex plate, but mostly occupied by the cardinal process of the opposite valve. Apical foramen sometimes retained. Teeth prominent and supported by thickened plates, which are continued in broad outward curves for more than half the length of the valve, returning and uniting in the unbonal cavity, thus limiting two linguiform muscular scars, inclosing a more or less clearly defined adductor impression.

In the brachial valve, the dental sockets are deep, and often appear to transect the cardinal area. The cardinal process is simple and erect, but by its coalescence with the short prominent crural plates, the posterior face appears trilobate. The crural plates end abrutly as in Orthothetes; becoming thickened at about the middle of their length, giving origin to two low ridges or septa, which at first approach each other, and thence continue forward with a slight divergence, thus forming the inner boundaries of two elongate muscular scars, which are less sharply defined on their outer margins. The muscular area is rendered quadripartite by two short transverse or oblique posterior furrows. Vascular impressions radial, sometimes digitate Shell-substance fibrous, sparsely punctate.

Type, *Plectambonites planissima*, Pander.

Distribution. Lower — Upper Silurian.

Christiania, Hall. 1892.

(Plate 19, Figs. 8–13.)

Shells usually longitudinally elongated, sometimes semielliptical in outline; normally concavo-convex. Surface smooth or covered with fine radiating lines which are crossed by stronger, rather regular concentric plications. In the pedicle-valve the cardinal area is moderately high and the delthyrium in its normal condition probably closed by a convex plate. The teeth are very divergent and from their bases extend the elevated margins of two linguiform muscular scars, traversing the shell for almost its entire length. These scars, which may be regarded as the diductors, inclose two, much shorter, but still elongate adductors. In the brachial valve the cardinal process is bipartite on its anterior face, each of the lobes being grooved behind; the crural plates are very long and divergent, terminating in elevated extremities or crura. The lower moiety of these plates is produced on each side of a strongly elevated muscular ridge, curving slightly inward on the sides, then outward on approaching the anterior margin of the valve, each branch recurving and passing backward, parallel to the median axis, as far as the base of the cardinal process. The symmetrical spaces thus limited are each divided transversely at about one-third their length from the hinge-line, by a somewhat lower vertical ridge. The four areas thus inclosed represent the posterior and anterior scars of the adductor muscles. Between the inner muscular walls, in the median line, is a low, rounded longitudinal ridge.

Type, *Christiana subquadrata*, Hall.

Distribution. Lower Silurian (?)—Devonian.

Leptænisca, Beecher. 1890.

(Plate 19, Figs. 14–21.)

Shell concavo-convex, attached to foreign objects by calcareous cementation of the pedicle-valve. Brachial valve concave; interior with a broad, more or less defined, spiral impression on each side of the median line, making a single volution. Adductor impressions small. Cardinal area narrow, bearing in the center two prominent bilobed, cardinal processes, separated to admit the vertical septum in the opposite beak. Pedicle-valve convex, area elongate triangular, fissure covered with a pedicle-sheath. Cardinal muscular scar supported on, or limited by a vertical septum, on each side of which, in the anterior half, is a small adductor scar. Shell structure punctate.

Type, *Leptænisca concava*, Hall (sp.).

Distribution. Lower Devonian.

Davidsonia, Bouchard. 1849.

(Plate 19, Figs. 22-24.)

Shell thick, plano-convex, transversely oval. Surface smooth or with concentric growth-lines, fixed to foreign bodies by the umbonal portion and the greater part of the surface of the pedicle-valve. Hinge-line straight and quite narrow. On the pedicle-valve the delthyrium is covered by a convex imperforate plate; the teeth are large, the dental lamellæ obscure. The muscular area is comparatively small, lying in the umbonal region, and is subdivided into two cardinal scars inclosing an elongate adductor. In the pallial region there is a low median septum which separates two conical callosities of the shell, having their apices directed toward the opposite valve. These protuberances are grooved by a spiral furrow which makes five or six volutions, and are frequently crossed by vascular sinuses.

In the brachial valve the chilidium is convex, embracing the base of the posterior face of the cardinal apophysis. The cardinal process has very much the same structure as in Plectambonites; consisting of a central, short, erect process, to which the crural plates are attached, giving it a trilobate appearance. These plates terminate abruptly at their distal extremities. The muscular area is quadruplicate and of about the same size as in the opposite valve. Two conical depressions in the pallial region correspond to the protuberances of the opposite valve. Shell-substance punctate (?).

Type, *Davidsonia Verneuili*, Bouchard.

Distribution. Middle Devonian (Europe).

Chonetes, Fischer de Waldheim. 1837.

(Plate 20, Figs. 1–14.)

Shells semicircular or transverse, usually normally concavo-convex, sometimes plano-convex. Hinge-line straight, making the greatest diameter of the shell. Pedicle-valve with a narrow concave or flat cardinal area; the delthyrium more or less completely covered by a convex imperforate deltidium. The upper margin of the area bears a single row of hollow vertical or divergent spines, which increase in length toward the cardinal angles; these spines are the prolongations of tubes which

ELEVENTH ANNUAL REPORT

OF THE

STATE GEOLOGIST

FOR THE YEAR 1891.

TRANSMITTED TO THE LEGISLATURE, JANUARY, 1892.

ALBANY:
JAMES B. LYON, STATE PRINTER.
1892.

STATE OF NEW YORK.

No. 65.

IN SENATE,

JANUARY, 1892.

ANNUAL REPORT

OF THE

STATE GEOLOGIST.

OFFICE OF THE STATE GEOLOGIST,
ALBANY, *January*, 1892.

To the Legislature of the State of New York:

In pursuance of chapter 247 of the Laws of 1888, I have the honor to transmit to the Legislature the Eleventh Annual Report of the State Geologist for the year 1891.

Very respectfully.

JAMES HALL,
State Geologist.

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REPORT.

To the Honorable the Board of Regents of the University of the State of New York:

Gentlemen:— During the past year, as in the several preceding years, the time of the State Geologist has been almost entirely devoted to the collection, preparation, systematic arrangement and and study of material for, and the preparation and publication of the Paleontology of New York. Volume VIII is now in press and the printing had progressed to more than 200 pages in February last, since which time no printing has been done. The manuscript for the completion of the volume, and that for the explanation of the plates has been ready for the printer since before that date, and nearly all of it was in hand at the time of suspension of printing. The plates for the illustration of the work are all completed.

The condition of this work, both as regards the volume in press and the preparation of the material, manuscript, drawings and lithographic plates for the succeeding portion of the work on volume VIII, part ii, will be given in detail further on.

During the past year it has been necessary to turn aside from this work to give attention to a subject of much interest and importance to our knowledge of the character, mineral and fossil contents and succession of the strata in central New York, from the horizon of the Genesee slate to the Salt group of Onondaga.

In November last the State Geologist received a letter from M. L. Townsend, Vice-president of the Livonia Salt and Mining Company, of Livonia, Livingston county, and of Broadway, New York, of which the following is a copy:

Livonia Salt and Mining Company,
Livonia, N. Y., *November* 3, 1890.

The Honorable the State Geologist, Albany, N. Y.:

Dear Sir. — We are engaged in sinking a shaft 12 by 24 feet at this place for the purpose of mining salt. The depth of the shaft will be about 1400 feet, and we have to go through from 600 to 700 feet of shale rock, and about the same thickness of lime rock, consisting of a stratum of Corniferous and also of Helderberg. Both the shale and the lime rock will contain many interesting and perhaps valuable specimens which your department may desire to obtain. If so, we will be glad to aid you in securing them, and to render you facilities for examinations of the rock formations if you wish to make them.

Respectfully yours.
(Signed.) M. L. TOWNSEND,
Vice-president.

To this letter I replied, thanking Mr. Townsend in behalf of the State for his interest in the subject and the consideration he had shown, and expressing myself very desirous of taking advantage of his kind offers. In reply to my letter I received the following:

LIVONIA SALT AND MINING COMPANY,
LIVONIA, N. Y., *November* 10, 1890.

Hon. JAMES HALL, *State Geologist:*

DEAR SIR.— Answering your inquiries of the sixth instant, I beg to state that our shaft is now down about seventy feet, and we have just entered the shale rock. We will be somewhat delayed for a few days in the erection of machinery, but in about two weeks we intend to be blasting in the rock, and to continue the work day and night. It will take about two years to complete the shaft.

Respectfully yours.
(Signed.) M. L. TOWNSEND.

I brought this subject before the secretary of the Regents, with my own advocacy of the work, but as there appeared to be no money available for such purposes nothing was done. The subject was again brought before the Regents at their annual meeting in December and the following resolution was offered by Regent Harris at the meeting of the committee on the State Museum, the same being afterwards voted unanimously by the Regents.

"That the Legislature be asked to appropriate $1,000 a year for two years to meet the expense of securing specimens and making records of the geological formation in the shaft to be sunk 2,000 feet at Livonia."

A copy of this resolution was sent by Secretary Dewey to the chairman of the committee of ways and means of the Assembly on March 10, 1891, but as the committee had already reported the supply bill no action could be taken. Subsequently a bill was introduced into the Assembly* providing for the completion of the Paleontology and the Geological Map and making provision for the work on the Livonia salt shaft, in the following terms:

"To enable the State Geologist to accept the offer of the Livonia Salt Company, to allow the State without charge to make records of the geological formation and to select specimens of value found in the salt shaft, covering 12x22 feet, which the company is now sinking to the depth of 2,000 feet, at Livonia, the sum of $2,000."

The bill after having passed the House was met by the deadlock in the Senate and failed to become a law. I then proposed to expend, for the purposes of the Livonia shaft exploitation, the money which had been apportioned from the general Museum appropriation for the geological and paleontological work of the year, which sum I was informed was about $800.

I then went to Livonia to examine the situation and facilities for the work, and after some preliminary arrangement with the manager of the work I sent for Mr. D. D. Luther, of Naples, with whom I had had previous correspondence regarding the undertaking. I made an arrangement with Mr. Luther to remain on the ground and to examine the rock as brought out of the shaft; to keep a record of the progress of the work; to note the nature of the rock passed through, its changes of character and to collect the fossils from the same, recording their relative depth from the surface, and other facts of interest or importance.

Unfortunately for the completeness of our record, the work in the shaft had already progressed to the depth of 350 feet before this arrangement had been consummated, and we have only been able to collect the data for that portion of the shaft from the materials upon the dump. However, we have ascertained that after passing through about sixty-eight feet of drift material (clay and gravel) the rock excavation was begun in the upper part of the Genesee slate, and the materials obtained from the output have been sufficient to complete the record, in a general way, to the point when the daily observations of the work began from the actual excavations in progress. The shaft has now progressed to the depth of about 750 feet, and we have full records of the strata passed through since the last week in May of the present year. Large collections of fossils have been made and twenty-eight boxes of specimens have been sent down to the State Hall. Some of these boxes have been opened and the contents examined, as noticed in the accompanying communication from Prof. Clarke. The final result will bring to the Museum collections a large amount of material from authentic horizons, and the observations made during their collection will show the vertical distribution of the species, and give us important information regarding the condition of the seabottom and the accumulation of sediments during this period.

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* Assembly bill 1441.

It has not been thought desirable to compile a section of the rocks, with notes on their contained fossils, at this time, but the accompanying list of species will give some information of interest. This work when completed, and the fossils compared with the nature and succession of the deposits, will form an interesting chapter in the geological history of the State.

LIVONIA SALT SHAFT.

Fauna of the Hamilton shales from the base of the Genesee, at 225 feet to a depth of 350 feet. Rocks soft, compact bluish shale, crumbling rapidly on exposure; with occasional very thin calcareous bands.

Abundant and characteristic.
Phacops rana,
Cryphaeus Boothi,
Homalonotus Dekayi.
Glyptodesma erectum,
Ambocoelia umbonata,
Lingula punctata.

Common.
Platyostoma lineatum,
Aviculopecten princeps,
A. scabridus,
Actinopteria decussata,
Grammysia arcuata,
Spirifer mucronatus,
S. audaculus,
Chonetes scitula,
Dignomia alveata,
Streptelasma rectum,
Michelinia stylopora,
Polypora multiplex,
Stictopora incisurata.

Occasional.
Proetus macrocephalus,
Orthoceras nuntium,
Tentaculites bellulus,
Styliolina fissurella,
Platyceras subrectum,
P. symmetricum,
Aviculopecten scabridus,
A. exactus,
Pterinopecten undosus,
Lyriopecten orbiculatus,

Grammysia alveata,
G. bisulcata,
Palaeoneilo tenuistriata,
P. fecunda,
P. plana.
Strophodonta junia,
S. inaequistriata,
Streptorhynchus arctostriata,
Productella spinulicosta,
Spirifer Marcyi,
Atrypa spinosa,
Leiorhynchus quadricosta,
Modiomorpha concentrica,
Goniophora angulata,
Cypricardinia indenta,
Tellinopsis subemarginata,
Orthonota undulata,
O. parvula,
Microdon tenuistriata,
Prothyris lanceolatus,
Atrypa reticularis,
Athyris spiriferoides,
Spirifer sculptilis,
Tropidoleptus carinatus,
Strophodonta perplana,
Pholidops Hamiltoniæ,
Orbiculoidea media,
Lingula Delia,
L. maida,
L. ligea,
L. densa,
L. sp. nov.,
Fenestella sp?
Glauconome carinata,
Heliophyllum Halli,
Amplexus intermittens.

Rare.

Bellerophon Leda,
Aviculopecten ornatus,
Modiomorpha macilenta,
M. concentrica,
Lunulicardium? sp. nov.,
Cryptonella planirostra,
Terebratula Ontario,
Strophodonta concava,
Chonetes coronata,
Orthis Vanuxemi,
Orbiculoidea humilis,
O. grandis,
Goniatites uniangularis,
Leptodesma Rogersi,
Spirifer granuliferus,
Pentamerella papilionensis,
Favosites Argus,
Reptaria stolonifera,
Chaetetes fruticosus,
Dictyonema Hamiltoniæ,
Platycrinus sp?

The included thin calcareous bands contain

Proetus macrocephalus,
Platyceras symmetricum,
Actinopteria decussata,
Spirifer fimbriatus,
S. granuliferus,
S. medialis,
Lichenalia vesciculata,
Stictopora incisurata.

Before commencing the shaft a boring* was made through the strata to the depth of 1,507 feet. The records of this boring are as given below:

	Feet.	Feet.
Clay, gravel and sand	56	56
Shale rock	464	520
Sand rock	10	530
Shale rock	302	832
Corniferous limestone (flint rock)	133	965
Hydraulic limestone	45	1,010

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* The locality of the boring is about 1,000 feet distant from the shaft opening, in a northerly direction.

	Feet.	Feet.
Limestone	313½	1,323½
Shale and salt	11½	1,335
Pure salt	35	1,370
Salt and shale	8	1,378
Pure salt	15	1,395
Soft shale	116	1,507

The bottom of the shaft is now nearing the base of the Hamilton group, and we may expect within a few days that the Corniferous limestone will have been reached.

The observations made in the progress of this shaft will serve not only as a guide in other similar works to be undertaken in the salt bearing area within the State, but they will serve to prove the nature and thickness of some of the strata in Central New York, which can not so well be determined from the exposures on the natural outcrops of the formations.

Should the work in the shaft be continued and kept up at the rate which it has been going on during the past ten months, the final result may be reported before the end of 1892.

The money made available by the arrangement already mentioned proved to be only about $600 and at the time of this writing, expenses had already been incurred to more than that amount, and some other means must be devised for the continuance of the work.

In my report of last year I gave a pretty full account of the condition of the work upon the Paleontology of the State, volume VIII, pt. i, being then in press and printed to more than 250 pages. The printing was continued till February when there were in type over 300 pages and the remainder of the manuscript in hand or ready for the printer. At this point the printing ceased, ostensibly for want of means to go on with the work, the money originally appropriated having been expended, and since that time till the present writing no arrangement has been made for the continuance of the work. Had the printing gone on from February as in the preceding few months the volume would have been published in April last. It is certainly a great misfortune to the author and to the State, as well as to the entire scientific public, that the publication of this work should have been so long delayed, when the expenditure of $1,000 would have completed the volume.

In the meantime, and for a large portion of the past year the writer, with the aid of the regular assistant in Paleontology, Prof. Clarke, and a special private assistant, Mr. Schuchert, has been occupied in bringing together and preparing material in the way of collections; the general bibliography and the special discussions upon the genera for the second part of volume VIII.

As already stated, volume VIII, part i, has been put into type to over 300 pages, and will be completed in about 350 pages exclusive of index, which has been prepared as far as the printed matter has been paged.

Of the text of volume VIII, part ii, 207 manuscript pages have been prepared. This is equivalent to about 125 pages of printed matter. Nearly twice as much more will be required to complete the discussions. In addition to the manuscript prepared, about ninety pen-and-ink drawings for the text have been made to show the structure of the spirals and loops, etc., in various genera.

Volume VIII, part i, will contain forty-two lithographic plates, numbered as follows:

I. Inarticulata: I, II, III, IV, IVA, IVB, IVC, IVD, IVE, IVF, IVG, IVH, IVK.

II. Articulata: V, VA, VB, VC, VI, VIA, VII, VIIA, VIII, IX, IXA, X, XI, XIA, XIB, XIC, XII, XIII, XIV, XV, XVA, XVB, XVI, XVII, XVIIA, XVIII, XIX, XX.

With the exception of Plate XX, all have been printed, and that one lithographed and proved.

Of the plates to accompany part ii, the following have been printed: XXI, XXII, XXIII, XXIV, XXV, XXVI, XXVII, XXVIII, XXX, XXXI, XXXII, XXXIII, XXXIV, XXXV, XXXVI.

The following have been drawn on stone and proved: XXIX, XXXVII, XXXVIII, XL, XLVIII, and the following are lithographed but not yet proved: XLI, XLII, XLIII, XLIV, XLV, XLVI, XLVII.

The drawings on hand are sufficient to furnish the lithographer with four plates, and a few additional drawings will be sufficient to complete ten more. For the full illustration of the volume it will require from twenty to twenty-five plates in addition to these, and will necessitate the making of from 400 to 500 new drawings.

THE FOLLOWING IS A LIST OF PREPARATIONS OF SPIRALS, LOOPS AND HINGE-PLATES.

[Made by Prof. J. M. CLARKE, for volume VIII., part ii.]

1. Spirifer radiatus	3
2. S. medialis	1
3. S. Whitneyi	1
4. S. perlamellosus	1
5. S. Orestes	2
6. S. subumbona	1
7. S. Niagarensis	2
8. S. crispus	2
9. S. perplexus	2
10. S. Oweni	14
11. S. gregarius	8
12. S. arenosus	18
13. S. pennatus	2
14. S. granuliferus	1
15. Ambocœlia umbonata	10
16. Crytina umbonata	5
17. C. Hamiltoniæ	7
18. Athyris spiriferoides	8
19. A. subtilita	12
20. A? congesta	7
21. A. ambigua	1
22. A. trinuclea	8
23. A. Royssi	1
24. A. subquadrata	5
25. A. concentrica	1
26. A. sp?	1
27. A? Junia	3
28. A. Angelica	1
29. A. sublamellosa	2
30. A. vittata	16
31. Merista sp. n	4
32. M? scalprum	1
33. Meristella nasuta	2
34. M? cylindrica	1
35. M? nitida	14
36. M? naviformis	3
37. M. bella	3
38. M. Haskinsi	1
39. M. Doris?	12
40. M. Barrisi	1
41. M. laevis	2
42. M. lenticularis	1
43. M? intermedia	2
44. Meristina Maria	15
45. M. rectirostra	4
46. Pentagonia unisulcata	4
47. Charionella scitula	4
48. Bifida lepida	5
49. Kayseria lens	7
50. Hindella Prinstana	1
51. H. umbonata	3
52. Nucleospira concinna	12
53. N. ventricosa	2
54. N. pisiformis	3
55. N. elegans	1
56. Retzia Adrieni	7
57. R. Barrandii	1
58. R. evax	15
59. R? sobrina	1
60. R? longirostris	2
61. Rhynchospira formosa	6
62. R. sp?	11
63. Trematospira camura	2
64. T? Deweyi	3
65. T? hirsuta	7
66. T. multistriata	4
67. T. perforata	1
68. Eumetria Mormoni	11
69. E. Verneuiliana	6
70. E. vera	8
71. Atrypa reticularis	12
72. A. marginalis	1
73. A. spinosa	1
74. A? bisulcata	4
75. Zygospira modesta	5
76. Z. erratica	2
77. Z. recurvirostra	16
78. Z. Kentuckiensis	4
79. Z. Anticostiensis	1
80. Cœlospira? Camilla	4
81. C. concava	5
82. C. acutiplicata	2
83. C? imbricata	6
84. Leptocœlia fimbriata	1
85. Koninckina Leonhardi	4
86. Rhynchonella Indianensis	1
87. R. neglecta	2
88. R? cuneata	2
89. Anastrophia internascens	1
90. Camarophoria Schlotheimi	1
91. C? eucharis	3
92. C. calcifera	1

93.	Triplesia lateralis	4
94.	Rensselæria mutabilis	3
95.	R. Suessana	8
96.	Terebratula sp?	4
97.	T? Calvini	1
98.	Cryptonella planirostra	3
99.	Dielasma bovidens	2
100.	Vitulina pustulosa	3
101.	Tropidoleptus carinatus	1
102.	Eichwaldia reticulata	2
	Total	468

A LIST OF THE GENERA OF THE PALAEOZIC BRACHIOPODA,

giving citations to the printed portion of the Paleontology of New York, volume VIII, part i, to the manuscript determinations for parts i and ii, and indicating the genera to be discussed in the remainder of the work.

(Terms regarded as synonyms are in *italics* and unnumbered.)

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117. Martinia, McCoy, 1844	do	do
118. Reticularia, McCoy, 1844	do	do
119. Martiniopsis, Waagen, 1883	do	do
120. Cyrtia, Dalman, 1828	do	do
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123. Cyrtina, Davidson, 1858	do	do
124. Ambocœlia, Hall, 1860	do	do
125. Metaplasia, nom. propos	do	do
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130. Dicamara, nom. propos	do	do
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132. Charionella, Billings, 1861	do	do
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134. Pentagonia, Cozzens, 1846	do	do
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136. Actinoconchus, McCoy, 1844	do	do
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138. Seminula, McCoy, 1844	do	do
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142. Bifida, Davidson, 1882	do	do
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144. Eumetria, Hall, 1864	do	do

145.	Acambona, White, 1862	In manuscript subject to revision.	
146.	Hustedia	do	do
147.	Retzia, King, 1850	do	do
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151.	Homœospira, nom. propos	do	do
152.	Ptychospira, nom. propos	do	do
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159.	Gruenewaldtia, Tschernyschew, 1885	do	do
160.	Karpinskia, Tschernyschew, 1885	do	do
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168.	Rhynchonella, Fischer de Waldheim, 1809	Discussions not yet prepared.	
169.	Cyclothyris, McCoy, 1844	do	do
170.	Hypothyris, Phillips, 1841	do	do
171.	Wilsonia, Quenstedt, 1871	do	do
172.	Uncinulus, Bayle, 1878	do	do
173.	Terebratuloidea, Waagen, 1883	do	do
174.	Rhynchotrema, Hall, 1860	do	do
175.	Rhynchopora, King, 1856	do	do
176.	Rhynchoporina, Œhlert, 1887	do	do
177.	Eatonia, Hall, 1857	do	do
178.	Stenocisma, Conrad, 1839	do	do
179.	Rhynchotreta, Hall, 1879	do	do
180.	Liorhynchus, Hall, 1860	do	do
181.	Pentamerus, Sowerby, 1813	do	do
182.	Zdimir, Barrande, 1881	do	do
183.	Sieberella, Œhlert, 1887	do	do
184.	Conchidium, Linné, 1760	do	do
185.	Gypidium, Dalman, 1828	do	do
186.	Gypidula, Hall, 1867	do	do
187.	Pentamerella, Hall, 1867	do	do
188.	Camarophoria, King, 1846	do	do
189.	Barrandella nom. propos	do	do

190. Lycophoria, Lahusen, 1885	Discussions not yet prepared.	
191. Anastrophia, Hall, 1867	do	do
192. Brachymerus, Shaler, 1865	do	do
193. Camarella, Billings, 1859	do	do
194. Syntrophia, gen. nov	do	do
195. Stricklandinia, Billings, 1863	do	do
196. Amphigenia, Hall, 1867	do	do
197. Clorinda, Barrande, 1879	do	do
198. Branconia, Gagel, 1890	do	do
199. Porambonites, Pander, 1830	do	do
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206. Oldhamina, Waagen, 1883	do	do
207. Stringocephalus, Defrance, 1827	do	do
208. Terebratula, Muller, 1776	do	do
209. Dielasma, King, 1850	do	do
210. Epithyris, King, 1850	do	do
211. Waldheimia, King, 1850	do	do
212. Cryptacanthia, White and St. John, 1868	do	do
213. Eudesia, King, 1850	do	do
214. Hemiptychina, Waagen, 1883	do	do
215. Centronella, Billings, 1859	do	do
216. Cryptonella, Hall, 1861	do	do
217. Rensselaeria, Hall, 1859	do	do
218. Newberria, Hall, 1891	do	do
219. Meganteris, Suess, 1856 = (Megalanteris)	do	do
220. Notothyris, Waagen, 1882	do	do
221. Richthofenia, Kayser, 1883	do	do

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November, 1890 — September, 1891.

By Donation.

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Bernix Tatii, Jones. Yoredale series. Walwick grange, Northumberland	2
Cypris punctata. Upper Purbeckian, Meups Bay	1
C. leguminella. Upper Cypris shales, Meups Bay	1
C. Purbeckensis. Lower Purbeckian, Ridgeway Hill	2
C. Purbeckensis. Lower Purbeckian, Worbarrow Bay	2
G. H. Mahan, Norwich, N. Y.:	
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G. Lindström, Stockholm, Sweden :	
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The Assistant Palæontologist :	
Fossils from a pleistocene shell marl, Canandaigua Lake, N. Y.	
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H. thyroides, Say	15
H. Sayi, Binney	1
H. alternata, Say	13
H. tridentata, Say	20
H. fuliginosa, Griffith	2
H. appressa, Say	4
H. palliata, Say	1
H. perspectiva, Say	3
H. striatella, Anthony	2
H. labyrinthica, Say	11
H. monodon, var. fraterna	4
Hyalina lineata, Say	3

	No. specimens.
Hyalina arborea, Say	14
Hy. viridula, Say	4
Hy. fulva, Say	3
Zonites suppressa, Say	8
Cionella subcylindrica, Linné	2
Succinea ovalis, Gould	4
Pupa contracta, Say	2
P. armifera, Say	1
P. curvidens, Gould	2
Carychium exiguum, Say	2
(Identifications corrected and verified by Mr. W. B. Marshall.)	
Emmett Brown, Belfast, N. Y.:	
Retzia Eugenia, Bill. Hamilton group, York, N. Y	7
Nucleocrinus sp.? Hamilton group, York, N. Y	1
Dr. E. Holzapfel, Aachen, Germany:	
Bifida lepida. Middle Devonian, Pelm	10
W. R. Billings, Ottawa, Canada :	
Atrypa bisulcata. Trenton group, Ottawa	7
Charles Schuchert, Albany, N. Y.:	
Palæaster ? sp. Clinton group, Clinton, N. Y.	1
W. B. Marshall, Albany, N. Y.:	
Spirifer arrectus. Oriskany sandstone (boulder), New Baltimore, N. Y.	2
Platyceras sp.? Lower Helderberg limestone, New Baltimore, N. Y.	1
C. F. Goodwin, Cleveland, Ohio:	
Coal plant. Ashland, Pa.	1
Agnes Crane, Brighton, England:	
Orthis hybrida. Wenlock, Benthall Edge, Shropshire	11
O. elegantula. Wenlock, Benthall Edge, Shropshire	9
Nucleospira pisum. Wenlock, Benthall Edge, Shropshire	3
Spirifer crispus. Wenlock, Benthall Edge, Shropshire	3
Glassia obovata. Wenlock, Benthall Edge, Shropshire	2
Atrypa reticularis. Wenlock, Benthall Edge, Shropshire	5
Porambonites ? Lower Silurian, near St. Petersburg	3

	No. specimens.
Athyris ambigua. Carboniferous, Tyrone, Ireland	1
A. protea. Carboniferous, Caucasus	1
A. planosulcata. Carboniferous, Welton, Staffordshire.	1
Athyris? sp? Locality?	1
Terebratula sacculus. Carboniferous, Welton, Staffordshire.	4

The Assistant Palæontologist:

Lepadocrinus sp? Lower Pentamerus limestone, Coeymans, N. Y	1
Spirifer Vanuxemi. Tentaculite limestone, Coeymans, N. Y.	1
Leptæna rhomboidalis. Corniferous limestone, Canandaigua, N. Y	1
Orthoceras sp. Chemung group, Jasper, N. Y	1
Modiomorpha. Chemung group, Jasper, N. Y	2
Total	244

BY EXCHANGE.

Dr. D. F. Lincoln, Geneva, N. Y.:

Centronella impressa. Hamilton group, Bellona, N. Y	6
Spirifer asper. Hamilton group, Slate Rock Falls, Geneva, N. Y.	1
S. granuliferus. Hamilton group, Slate Rock Falls, Geneva, N. Y	1
Pharetrella tenebrosa. Marcellus shales, Slate Rock Falls, Geneva, N. Y	1
Dinicthys Lincolni, Claypole, 1893 (type), Marcellus shales, Slate Rock Falls, Geneva, N. Y	1
Orthis Vanuxemi. Hamilton group, Slate Rock Falls, Geneva, N. Y	1
Lingula sp? Corniferous limestone, near Geneva	1

A. L. Arey, Rochester, N. Y.:

Meristina nitida. Clinton group, Rochester	35
Atrypa reticularis. Clinton group, Rochester	1
Pentamerus sp. nov. Clinton group, Rochester	1
Rhynchonella sp. Clinton group, Rochester	2

G. L. Houser, Iowa City, Iowa:

Stromatopora. Devonian, Iowa City, Ia	2
Diphyphyllum. Devonian, Solon, Ia	1
Megistocrinus Farnsworthi. Devonian, Solon, Ia	5

	No. specimens.
Orthis Iowensis. Devonian, Iowa City, Ia	9
Atrypa reticularis. Devonian, Buffalo, Ia	5
Atrypa reticularis. Devonian, Solon, Ia	4
A. aspera. Devonian, Solon, Ia	16
Athyris vittata. Devonian, Buffalo, Ia	7
Athyris vittata. Devonian, Iowa City, Ia	14
Spirifer Parryanus. Devonian, Buffalo, Ia	3
Spirifer Parryanus. Devonian, Montpelier, Ia	8
S. pennatus. Devonian, Solon, Ia	6
Pentamerus coms. Devonian, Solon, Ia	3
Rhynchonella alta. Devonian, Solon, Ia	18
Terebratula Iowensis. Devonian, Robert's Ferry, Ia	1
Straparollus cyclostoma. Devonian, Coralville, Ia	5
Dr. Th. Tschernyschew, St. Petersburg (not before reported):	
Pentamerus Bashkiricus. Devonian, Russian Urals	1
P. galeatus. Devonian, Russian Urals	3
Rhynchonella livonica. Devonian, Russian Urals	2
R. Meyendorfi, Devonian, Russian Urals	1
R. procuboides. Devonian, Russian Urals	2
R. cuboides. Devonian, Russian Urals	2
Spirifer bifidus. Devonian, Russian Urals	2
S. pachyrhynchus. Devonian, Russian Urals	2
S. Jeremejewi. Devonian, Russian Urals	3
S. elegans. Devonian, Russian Urals	2
S. Anossofi. Devonian, Russian Urals	5
Atrypa reticularis. Devonian, Russian Urals	2
A. aspera. Devonian, Russian Urals	4
A. Alinensis. Devonian, Russian Urals	2
Cyrtia Murchisoni. Devonian, Russian Urals	2
Orthis Ivanovi. Devonian, Russian Urals	1
O. striatula. Devonian, Russian Urals	1
Camarophoria subreniformis. Devonian, Russian Urals	1
Chonetes plebeia. Devonian, Russian Urals	1
Charles Schuchert, Albany, N. Y.:	
Specimens from the Marcellus shales and limestone at Chapinville, Mertensia and Canandaigua, N. Y.; consisting principally of cephalopoda and plants	200
Posidonomya Becheri. Culm. Bredelar, Germany	1
P. tuberculata. Culm. Lautenthal, Germany	2

	No. specimens.
Goniatites crenistriatus. Culm. Winterberg, Germany	2
Goniatites crenistriatus. Culm. Schalke, Germany	2
G. coronula. Culm. Clausthal, Germany	1
Plants. Coal measures. Pomeroy, Ohio, (slabs)	2
Platycrinus granosus. Coal measures, Tournai, Belgium	2
Ceratites nodosus. Muschelkalk. Göttingen, Germany	1
Monotis Alberti. Muschelkalk. Rüdersdorf, Germany	1
Rhynchoteuthis. Muschelkalk. Berklingen, Germany	1
Tæniodon Ewaldi. Rhætic. Elliehausen, Germany	2
Gresslya abducta. Jura. Dohnsen, Germany	5
Perna isognomoides. Jura. Dohnsen, Germany	1
Ammonites Gervillei. Jura. Dohnsen, Germany	8
A. polyplocus. Jura. Fichtelgebirge, Germany	1
Pholadomya Murchisoniana. Jura. Ollerhausen, Germany	1
P. acuticosta. Kimmeridge, Holtzen, Germany	3
Pecten. Kimmeridge, Holtzen, Germany	1
Cyprina Brongniarti. Kimmeridge, Holtzen, Germany	4
Cercomya excentrica. Kimmeridge, Holtzen, Germany	1
Exogyra virgula. Kimmeridge, Holtzen, Germany	40
Fish tooth. Kimmeridge, Holtzen, Germany	1
Exogyra arietina. Cretaceous. Mountain City, Texas	11
Catopygus fenestratus. Cretaceous, Ciply	2
Sponge spicules. Cretaceous. Vorwohle, Germany	1
Ostrea gigantea. Tertiary. Morro, Cal	2
O. Idrianensis. Tertiary. Morro, Cal	4
Pecten discus. Tertiary. Morro, Cal	1
Mytilus Inezensis. Tertiary. Morro, Cal	1
Pecten sp. Tertiary. Morro, Cal	2
P. Veatchi. Tertiary. Morro, Cal	1
Melania. Tertiary. Paris, France	1
Cypræa coccinella. Tertiary, Palermo, Italy	1
Fusus multisulcatus. Tertiary. Basle	1
Planorbis euomphalus. Tertiary. Headon Hill, England	2
Limnea longiscata. Tertiary. Headon Hill, England	2
Pectunculus Philipi. Post-tertiary, Hitzaeker, Germany	2
Clausilia similies. Post-tertiary. Zierenberg, Germany	4
Bulimus montanus. Post-tertiary. Zierenberg, Germany	3
Planorbis carinatus. Post-tertiary. Saxe-Weimar, Germany	1
Limnæa palustris. Post-tertiary. Saxe-Weimar, Germany	9
Helix incarnata. Post-tertiary. Zierenberg, Germany	5

	No. specimens.
Reptilian coprolites. Post-tertiary. Georgetown, S. Car	6
Elephant tooth. Post-tertiary. Charleston, S. Car	1
Emmett Brown. Belfast, N. Y.:	
Retzia Eugenia, Bill. Hamilton group. York, N. Y	6
Taxocrinus. Chemung group. Belfast	1
Rhynchonella cf. pugnus. Chemung group. Belfast	2
Terebratula cf. navicella. Chemung group. Belfast	10
T. sp. Chemung group. Belfast	4
Centronella Julia ?. Chemung group. Belfast	1
Athyris Angelica. Chemung group. Belfast	5
E. A. Parks, Clarence, N. Y.:	
Dalmanites aspectans. Corniferous limestone. Clarence	1
Atrypa congesta. Clinton group (drift)	1
E. H. Raymour, Kansas City, Mo.:	
Proetus crassimarginatus. Corniferous limestone. Waverly, Ind	28
P. cf. macrocephalus. Corniferous limestone. Waverly, Ind.	9
Brachiopods (various species), Corniferous limestone. Waverly, Ind	42
Gastropods. Corniferous limestone. Waverly, Ind	7
Aviculopecten sp. Corniferous limestone. Waverly, Ind	2
F. B. Loomis, Spencerport, N. Y.:	
Brachiopods. Clinton shale. Buell avenue, Rochester	200
Dr. Friedrich Schmidt, Reval. Russia:	
Eurypterus Fischeri. Rootsikull, Œsel	2
Pterygotus Osiliensis. Rootsikull, Œsel	2
Porambonites gigas. Lyckholm, Estland	1
Leptocœlia Deshayési. Estland	1
Atrypa imbricata. Estland	1
Obolus Apollinis. Tegelecht	1
Onchus Murchisoni. Œsel	1
Pentamerus borealis. Weissenfeld	3
Volborthella tenuis. Reval	1
Thyestes verrucosus. Rootsikull, Œsel	1
Pachylepis. Œsel	1
Tentaculites curvatus Beyrichia Wilckensiana } Œsel	1

	No. specimens
Olenellus Mickwitzi. Estland	1
Platyschisma helicites. Œsel	2
D. G. Anderson, Keokuk. Iowa:	
Brachiopods (various species). Keokuk limestone. Keokuk	60
L. A. Cox:	
Brachiopods (various species), Keokuk limestone. Keokuk	73
Total	1,002

BY COLLECTION.

Jacob Van Deloo, November, 1890:

Fossils from the Chazy limestone. Keeseville. N. Y. (museum ticket, 1,113)	244

D. D. Luther, May–July, 1891:

Fossils from the Genesee and upper Hamilton shales at the Livonia salt shaft, 19 boxes, 1 barrel.

Fossils, September, 1891, from the middle Hamilton shales, 9 boxes.

Martin Sheehy and Jacob Van Deloo, September, 1891:

Fossils from the Oriskany fauna, near Hudson, N. Y., 9 boxes (approximately 700 specimens).

SUMMARY OF RECEIPTS.

By donation	244
By exchange	1,002
By collection (approximately)	2,600
Total	3,846

During the past year two school collections have been selected, labeled and sent out as follows: Parker Union School of Clarence, New York, containing 170 species and 241 examples. St. Lawrence University, Canton, St. Lawrence county. New York, 140 species and 217 examples.

I report herewith a communication from Prof. J. M. Clarke, Assistant Palæontologist, together with a List of Original and Illustrated specimens in the Palæontological collections. Part I, CRUSTACEA. It is intended to continue this work until the list shall be completed in all classes of fossils embraced in the Palæontology of New York. The preparation of such a list of each class of fossils (to be illustrated) has been a long time contemplated by the writer and it is very gratifying to be able to present at this time the first installment of the work.

The requirement to present the Annual Report in October has necessarily left unfinished several communications which would have been completed during the coming months, had the presentation of the report been delayed till the end of the year, which has been the custom until the present occasion.

Very respectfully,
Your obedient servant.
JAMES HALL,
State Geologist.

ALBANY, *October*, 1891.

CATALOGUE

OF THE

Collection of Geological and Palæontological Specimens, Donated by the Albany Institute to the State Museum.

[Prepared by Professor John M. Clarke and communicated to Professor James Hall, State Geologist, December 1, 1891.]

CATALOGUE.

The collection of the Albany Institute was received at the State Museum in the month of August, and formally donated to the institution on the 6th of October, 1891.* When the fossils came into my hands I found them in bad condition. Such labels as existed had been gathered into piles and boxes by themselves, with the exception of the few instances in which they had been glued to the specimens. The majority of the specimens, however, bore a numeral ticket, which had been copied upon the separated labels, and by means of this arrangement the matching of the few labels with their specimens was not difficult. Fortunately, these labeled specimens constitute the most important part of the collection; they are mostly Trilobites, and embrace a number of the original types used by Dr. Jacob Green in his "Monograph of Trilobites of North America," with much other interesting material of the same class, and in addition are several type-specimens of Cephalopods from the Black River limestone, described by yourself in volume I of the Palæontology of New York.

Of this series of labeled specimens a few are evidently missing, but perhaps not as many as, under the circumstances, one might expect. It appears from the labels on the rest of the collection that the specimens were divided into groups, each with its own form of numerical ticket. It is understood that there was a manuscript register or catalogue of these specimens, but it was not found among the documents pertaining to the collection nor delivered with it, and subsequent careful search among the archives of the Institute has failed to discover it. The want of this catalogue has naturally added greatly to the task of identifying the specimens. On account of the historical value of this collection I have taken much pains to locate such material as proves to be a genuine contribution to the State Museum. By far the greater number of specimens are from familiar outcrops of the New York series of formations, and their source can be approximately indicated without much danger of error. For us the value of this collection lies almost wholly in its New York palæozoic. fossils; the few mesozoic and tertiary specimens being from scattered and uncertain American and European localities.

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*The extensive collection of minerals donated to the State Museum at the same time, together with other collections of natural history, have not come under the cognizance or control of the State Geologist, and no account of them can be given in this connection.

ALBANY INSTITUTE COLLECTION. FOSSILS.

I. A small series labeled by Prof. Amos Eaton, but without localities

"1 Gorgonia ripisteria Nobis" = *Polypora celsipora*, Hall.

In a fragment of decomposed Corniferous chert, apparently from western New York.

The original description of this species is as follows:

"*G. ripisteria*, very branching and net-form, spread out like a fan; branchlets subcompressed, coalescent, minutely striated: bark granulose. Found at Bethlehem in corniferous limerock; 1½ inches long." (Geological Text Book. 2nd. Ed., p. 43, pl. 4, fig. 47, 1832.)

"2 Coscinopora macropora"

From the Lower Helderberg shaly limestone.

"*C. macropora* (large-mouthed net-stone) patella-form, pores orbicular, interstices with greater or less punctures.

"In second graywacke on Becraft Mt., near Hudson. Very irregular in external form." (*Op. cit.* p. 43, pl. 5, figs. 59, 60.)

3 and 4 missing.

"5 Turbinolia mitrata" = a worn specimen of *Streptelasma corniculum*, Hall. Trenton limestone.

Original description:

"*T. mitrata* (mitred cone, smooth horn), subcompressed on the sides; apex incurved: lamellæ thickish, sub-connate and papillose at the surface, unequal, somewhat toothed, forming an ovate, stellate disk. My specimens average an inch in length. Found at Glens Falls." (*Op. cit.*, p. 39, pl. 3, figs. 32, 33.)

6, 7, 8 missing.

"9 Cyathophyllum ceratites." (*Cystiphyllum*) Corniferous limestone.

"10 Lithodendron dichotomum" = *Bythotrephis gracilis*, Hall. Trenton limestone.

Original description:

"*L. dichotomum* (cylindrical stone tree). Cespetose, erect. Subflexuose; branches dichotomous, densely striate; little stars excavated orbicularly. Very common at Glens Falls, lying between the layers of the limerock." (*Op. cit.*, p. 39, pl. 4, fig. 43.) The description and figures represent a true coral, which, if correct, do not apply to any of the known species from the Trenton limestone.

11 missing.

"12 Astrea stylophora "= *Michelinia stylopora* Eaton (sp.). Hamilton group.

Original description:

"*A. stylopora* (star stone). Hemispherical; little stars angle-tubular, approximating and contiguous, margin glabrous, lamellæ distant; the center of the column or star extended a little. Common on the south bank of Lake Erie; about one inch in diameter." (*Op. cit.*, p. 40, pl. 4, fig. 48.)

"13 Columnaria sulcata "= *Columnaria alveolata* (Goldfuss), Hall, Black River limestone.

Original description:

"*C. sulcata* (furrowed corals) tubes generally parallel and straight, sometimes a little curved; furrowed longitudinally and substriate; lamellæ of the stars radiating from the center, and the marginal ones alternating. Very abundant in transition limerock at Glens Falls, where it is generally dark brown. We find some there whose prismatic columns are six inches long." (*Op. cit.*, p. 41, pl. 5, fig. 51.)

"14 Columnaria alveolata "= *Favosites Helderbergiæ*, Hall, Lower Helderberg (Shaly limestone).

This is apparently Prof. Eaton's identification of Goldfuss' species. His description is:

"*C. alveolata* (coral cakes). Hemispherical (often concave, convex and sometimes flat) tubes unequal in length, striated longitudinally, and radiating from the base; those lamellæ of the little stars are rather remote which radiate from the center, the marginal ones alternating. Very abundant over the Coral cone on the Helderberg. They are from three inches in diameter to ten." (*Op. cit.*, p. 40, pl. 4, figs. 44, 45.)

"15 Sarcinula macrophthalma, var. prismatica." Label only.

16, 17, 18, 19 missing.

"20 Terebratula Perovalis." Label only.

21 missing.

"22 Terebratula spiriferoides, Nobis "= *Athyris spiriferoides*, Eaton (sp.). Hamilton group. (*Op. cit.*, p. 46.)

"23 Terebratula dimidiata " (*Pentamerella arata*, Hall). Corniferous limestone.

"24 Spirifer alternatus." Label only.

"25 Resembles Spirifer Walcottii. Probably near =*Spirifer macropleura*, Conrad." Lower Helderberg (Shaly limstone).

26 missing.

"27 A pentacrinite being the Encrinus dicyclus"=Crinoidal disks from the Hamilton or Chemung group.

"28. Encrinus transversus" =*Phytopsis tubulosa*, Hall.
Birdseye limestone.

Original description:

"*E. transversus* (birdseye pins) rings low or confluent, so that the column appears nearly or quite smooth; perforates strata transversely. Found in the lowest and most compact layers of metalliferous limerock. It is called Encrynal by Conybeare and Birdseye marble by stonecutters." (*Op. cit.*, p. 36.)

"29. Encrinus interruptus." Corniferous limestone.

"30. Productus depressus in 2d Graywacke" =*Leptæna rhomboidalis*, Wilckens. Lower Helderberg (Shaly limestone).

"31. Orthocera circularis" =*Orthoceras* sp.? probably from the Corniferous limestone. (*Op. cit.*, p. 29, pl. 3, fig. 27.)

"32 Cancer triloboides Nobis" =*Brongniartia carcinodea*, Eaton, 1832 =*Triarthrus Becki*, Green, 1832. Utica slate.

"33. Conularia quadrisulcata" =*Conocardium trigonale*, Conrad.
"Cyathophyllum ceratites" =*Zaphrentis* sp.?
"Gorgonia ripisteria" =*Polypora celsipora*, Hall (?).

II. The collection of TRILOBITES had been carefully labeled by the late Dr. T. R. Beck, and though these labels were all displaced, the numbering on both labels and specimens has facilitated their replacement. This collection is composed of some small lots not included in the serial numbering of the general collection, and a few embraced the initiatory portion of the latter.

1. Plaster-of-paris models of Trilobites described by Dr. Jacob Green in his "Monograph of the Trilobites of North America," 1832.

No. 1, Calymene Blumenbachii, Brongniart, Trenton Falls.
No. 2, C. callicephala, Green, "Hampshire, Virginia."
No. 5, C. platys, Green, Helderberg (3 specimens).
No. 6, C. microps, Green, near Ripley, Ohio. (?)
No. 9, C. macrophthalma, Brongniart, Leheighton, Pa.
No. 10, C. Bufo, Green, New Jersey.
No. 17, Asaphus caudatus, Brünnich, Ripley, Ohio.
No. 28, Cryptolithus tesselatus, Green, Champlain canal.
No. 31, Dipleura DeKayi, Green, Northumberland, Pa. (?)

No. 32, Trimerus delphinocephalus, Green, Williamsville, N. Y. (?)

No. 35, Nuttainia sparsa, Eaton, Coeymans, N. Y.

Also model of the original of Isotelus magnus, DeKay, Trenton Falls, N. Y.

2. *The James Eights collection:*

1, Cryptolithus tesselatus, Green, Glens Falls, N. Y.

2, Calymene bufo, Green, Helderberg.

3, Triarthrus Beckii, Green, 7 miles east of Little Falls, N. Y.

5, Asaphus (= *Dalmanites anchiops*, Green), Helderberg, N. Y.

6, Dalmanites anchiops, Green (without label).

8, Asaphus micrurus, Green (= *Dalmanites pleuroptyx*, Green) Helderberg, N. Y.

9, Dipleura DeKayi, Green, Black river, Jefferson county, N. Y. (?) "The heads of two trilobites in the Dudley limestone," (= Phacops Downingiæ), Dudley, England.

3. *The G. W. Clinton collection:*

(a) Dipleura DeKayi, Green (specimen mentioned in Green's Monograph, p. 80), Madison county, N. Y.

(b) "A Fragment of the Isotelus gigas" (Gov. Clinton's label), = Dipleura DeKayi, Green (specimen mentioned in Green's Monograph, p. 80), Steuben county (?? probably Madison county) N. Y.

(c) Dipleura DeKayi, Green (specimen mentioned in Green's Monograph, p. 80), Cazenovia, N. Y.

(d) "Head of the Isotelus, Cazenovia, Madison county" (Gov. Clinton's label), = Dipleura DeKayi (specimen mentioned in Green's Monograph, p. 80).

(e) Dipleura DeKayi, Green, Steuben (?? probably Madison) county, N. Y.

4. *Small miscellaneous lot:*

"Petrified crab or cancer in 2d Greywacke," = *Triarthrus Becki*, 2 specimens.

Dalmanites anchiops (without label). Fragment.

5. *Trilobites of the General Collection.*

I, a, 1. Calymene anchiops, Green. ORIGINAL. Ulster county, N. Y. *John R. Bleecker, Don.*

I, a, 2. Missing.

I, a, 3. Calymene platys, Green. Corniferous limestone, Coeymans, N. Y.

I, a, 4. Calymene bufo, Green. (The head.) Corniferous limestone, Bethlehem, N. Y. *T. R. Beck, Don.*

I, a, 5. Calymene Blumenbachii. ("Dudley Trilobite.") Ohio. *T. R. Beck, Don.*

I, a, 6. Calymene bufo. var. rana, Green. ORIGINAL. Seneca, Ontario county, N. Y. *M. H. Webster, Don.*

I, a 7. Dipleura DeKayi, Green. (Specimen mentioned in Green's Monograph, p. 80.) Cazenovia, N. Y. *L. C. Beck, Don.*

I, a, 8. Trimerus delphinocephalus, Green. ORIGINAL. (Also Palæontology of New York, vol. 2, pl. 68, fig. 3.) Banks of Lake Ontario, Monroe county, N. Y. *James Eights, Don.*

I, a 9. Trimerus delphinocephalus, Green. (Specimen mentioned in Green's Monograph, p. 82.) Banks of Lake Ontario, Monroe county, N. Y. *M. H. Webster, Don.*

I, a, 10. Calymene Blumenbachii, Brong. Canajoharie, N. Y. *James Eights, Don.*

I, a, 11. Asaphus micrurus, Green. Becraft's Mt., near Hudson, N. Y. *M. H. Webster, Don.*

I, a, 12. Asaphus Wetherilli, Green. ORIGINAL. Rochester, N. Y. *L. C. Beck, Don.*

I, a, 13. (*Calymene callicephala*, Green, Trenton limestone.) Label missing.

I, a, 14. Isotelus gigas, DeKay. Norway, Herkimer county, N. Y. *James Hadley, Don.*

I, a, 15. Isotelus (fragment). Trenton Falls, N. Y. *H. W. Snyder, Don.*

I, a, 16. Two worn specimens of Trilobite (*Calymene callicephala*, Green.) Trenton Falls, N. Y. *M. H. Webster, Don.*

I, a, 17. Calymene Blumenbachii. Trenton Falls, N. Y. *H. W. Bauman, Don.*

I, a, 18. (*Odontocephalus selenurus.* Corniferous limestone.) Label missing.

I, a, 19. Missing.

I, a, 20. Calymene bufo, Green. (Hamilton group. Locality missing.)

I, a, 21. Missing.

I, a, (b), 22. (*Dalmanites pleuruptyx*, Green. Lower Helderberg. The Heldeberg, N. Y.)

I, a, 23. Calymene bufo. (*Phacops Logani*, Hall.) Lower Helderberg limestone. Schoharie, N. Y. *J. Gebhard, Don.*

I, a, 24. Calymene bufo. (Hamilton group. Locality missing.) *C. Delafield, Don.*

I, a, 25. (*Isotelus gigas.* Trenton limestone.) Label missing.

I, a, 26. Calcareous slate with Trilobites (= *Triarthrus Becki*, Green), 7½ miles east of Little Falls, N. Y.

I, a, 27. (*Dalmanites anchiops*, Green. Schoharie grit.) Label missing.

I, a, 28. (*Dalmanites pleuroptyx*, Green. Delthyris shaly limestone.) Label missing.

I, b, 1. Isotelus. ORIGINAL (Palæontology of New York, vol. I, pl. 61, fig. 3g. There identified as *Isotelus gigas*, De Kay, but probably a distinct species). Crown Point, N. Y. *John James, Don.*

I, b, 2. (*Dalmanites pleuroptyx*, Green. Lower Helderberg group. The Helderberg, N. Y.)

I, b, 3. (*Dalmanites limulurus*, Green. Niagara group, Rochester, N. Y.)

I, b, 4. Asaphus caudatus (= *Dalmanites limulurus*. Green). Specimen described in Green's Monograph, p. 56, as *A. pleuroptyx.* Genesee river, N. Y. *James Eights, Don.*

I, b, 5. (*Dalmanites micrurus*, Green. Lower Helderberg group. The Helderberg, N. Y.)

I, b, 6. Asaphus selenurus, Eaton. Corniferous limestone. Helderberg. James Eights.

I, b, 7. Missing.

I, b, 8. Ceraurus pleurexanthemus, Green. 3 specimens. ORIGINALS. Trenton limestone. Newport, N. Y. *T. R. Beck, Don.*

I (II), b, 9. (*Dalmanites micrurus*, Green. ORIGINAL. Lower Helderberg, Schoharie county, N. Y.)

I, b, 10. Tail of Isotelus (*gigas*, De Kay). Trenton limestone. Mastigouche river, Canada. *T. R. Beck, Don.*

I, b, 11. (*Dalmanites micrurus*, Green. Lower Helderberg. The Helderberg, N. Y.)

I, b, 12. (*Dalmanites myrmecophorus*, Green. Corniferous limestone. N. Y.) Label missing. 2 specimens belonging together.

I (II), b, 13. (*Dalmanites pleuroptyx*, Green. ORIGINAL. Lower Helderberg (Shaly limestone), Albany county, N. Y.)

I, b, 14. Asaphus Hausmanni. (= *Phacops rana*, Green). Eaton coll. Hamilton group. Western, N. Y.)

I, b, 15. Asaphus caudatus (Eaton's label). (?) Oriskany fauna, near Hudson, N, Y.

I, b, 16. Asaphus caudatus (Eaton's label). (?) Oriskany fauna, near Hudson, N. Y.

I, b, 17. Asaphus in Greywacke. South Sea Islands (?) (Probably *Dalmanites* sp. nov. Oriskany fauna, near Hudson, N. Y.) *S. De Witt Bloodgood, Don.*

I, b, 18. (*Dalmanites pleuroptyx*, Green. Lower Helderberg group. Schoharie, N. Y.)

I, b, 19. Asaphus laticostatus, Green (= *Dalmanites pleuroptyx*, Green). Schoharie, N. Y. *J. Gebhard, Don.*

I, b, 20. Asaphus selenurus, Eaton. Corniferous limestone. Schoharie, N. Y. *J. Gebhard,* Don.

I, b, 21. Calymene bufo, Green (= *Phacops cristata*, var. *pipa*). Corniferous limestone. Schoharie, N. Y. *J. Gebhard, Don.*

See I, a, (b), 22.

I, b, 23. (*Dalmanites limulurus:* Green, Lockport,? N. Y.) Label missing.

I, c. 1. Trimerus delphinocephalus. Green. Genesee River, N. Y. *James Eights, Don.*

I, c, 2. Trimerus delphinocephalus. Green. (Specimens described in Green's Monograph, p. 82.) Williamsville (? probably Lockport), N. Y. *J. Hadley, Don.*

I, d, 1. Cryptolithus tesselatus. Green. Four specimens (1 missing). Glens Falls, N. Y. *M. H. Webster, Don.*

Also, Calymene platys. Green. ORIGINAL. Helderberg Mt. Albany county, N. Y. *T. R. Beck, Don.*

Two plaster moulds of Dipleura DeKayi. Green. Cazenovia, N. Y.

6. *Balance of the General Collection.*

These specimens are virtually without other label than the catalogue ticket, and as the catalogue is missing the restoration of localities is in many cases a matter of approximation. The great majority of the specimens, however, are from the State of New York and their origin is not a matter of much uncertainty. In this list the choicer specimens, which are really important additions to the collections of the State Museum are indicated by an asterisk on the margin of the page.

*I, b, 21. *Gonioceras anceps.* Hall. Black River limestone. Watertown, N. Y.

*I, b, 7. *Murchisonia.* Lower Pentamerus limestone. Helderberg.

I, (or II), b, 19, (*Orbiculordea graudis*, Vanuxem), Oriskany sandstone. The Helderberg, N. Y.

II, b, 1. Lower Helderberg limestone. Helderberg.

II, b, 2. Lower Pentamerus limestone. Helderberg.

II, b, 3. Missing.
II, b, 4. Lower Pentamerus limestone. Helderberg.
II, b, 5. Chert. Lower Carboniferous.
II, b, 6. Clinton group. Tennessee?
II, b, 7. Crinoid columns, Clinton group.
II, b. 8. Missing.
II, b, 9. *Arthrophycus Harlani.* Medina Sandstone. Western N. Y.
*II, b. 10. *Arthrophycus Harlani.* Medina Sandstone.
II, b, 11. Crinoid columns. Chemung group. N. Y.
II, b, 12. Crinoid columns. Chemung group, N. Y.
II, b, 13. Crinoid columns. Niagara group, Wisconsin?
II, c, 1. *Cornulites. Orthis.* Hudson River Sandstone, Niskayuna, N. Y.
II, c, 2. *Cornulites. Orthis. Modiolopsis.* Hudson River Sandstone, Niskayuna, N. Y.
II, c, 3. Crinoid columns. Delthyris Shaly limestone, Berne, N. Y
II, c, 4. Crinoid columns. Corniferous limestone, Eastern N. Y.
III, 2, b, 1. *Schizodus?* Locality? Europe.
III, 2, c, 1. *Gresslya.* Locality? Europe.
III, 2, d, 1. *Cyprina.* Locality? Europe.
III, 2, d, 2. *Glycimeris.* Locality? Europe.
III, 2, g, 2. *Cyprina?* Locality? Europe.
III, 2, k, 1. "Ostracite? West. Dist." *Limoptera macroptera,* Hamilton group, Central N. Y.
III, 2, k, 2. *Limoptera macroptera.* Hamilton group, Central N. Y.
III, 2, k, 3. Missing.
III, 2, k, 4. Missing.
III, 2, k, 5. Missing.
III, 2, k, 6. *Grammysia bisulcata.* Hamilton group, Central N. Y.
III, 2, l, 1. "Pectinite, Helderberg." *Hipparionyx proximus.* Oriskany sandstone.
III, 2, l, 2. "Pectinites in Greywacke." *Spirifer mucronatus,* Conrad. Hamilton group, Rensselaerville, N. Y.
III, 2, l, 3. *Spirifer mucronatus,* Conrad. Hamilton group, Rensselaerville, N. Y.?
III, 2, l, 4. *Spirifer mucronatus,* Conrad. Hamilton group, Rensselaerville, N. Y.?
III, 2, l, 5. *Spirifer mucronatus,* Conrad. Hamilton group, Rensselaerville, N. Y.

III, 2, l, 6. "Pectinite, West. Dist." *Spirifer granulosus*, Conr. Hamilton group, Western N. Y.

III, 2, l, 7 (2 specimens). "Pectinite, Helderberg." *Spirifer arenosus*, Conr. Oriskany sandstone.

III, 2, l, 8. *Orthis testudinaria.* Trenton limestone, "from Big Sandy Creek, Jefferson county, about two miles above its mouth."

III, 2, l, 9. *Rafinesquina alternata.* Trenton limestone, Central N.Y.

III, 2, l, 10. Missing.

III, 2, l, 11. Missing.

III, 2, l, 12. Missing.

III, 2, l, 13. Missing.

III, 2, l, 14. Missing.

III, 2, l, 15. Belemnite. Locality?

III, 2, l, 16. *Cyprina?* Lias? Locality?

III, 2, l, 17. Missing.

III, 2, l, 18. *Spirifer mucronatus*, Conr. Hamilton group, Central N. Y.

III, 2, l, 19. *S. arenosus*, Conr. Oriskany sandstone, Eastern N. Y.

III, 2, l, 19. S. disjunctus, Sow. Chemung sandstone, N. Y.

III, 2, m. 1. "Anomite, Helderbergh" *Rensselæria ovoides*, Hall. Oriskany sandstone, N. Y.

III, 2, m, 2. "Anomite, Rensselaerville" *R. ovalis*, Hall. Oriskany sandstone, N. Y.

III, 2, m, 3. *Atrypa reticularis*, Linn. Corniferous limestone, N. Y.

III, 2, m, 4. Missing.

III, 2, m, 5. *Meristella bella*, Hall. Lower Helderberg group, Albany county, N. Y.

III, 2, m, 6. *Atrypa, Meristella, Proetus*, etc. Schoharie grit, Albany county, N. Y.

III, 2, m, 7. Missing.

* III, 2, m, 8. "Anomite, Rensselaerville," *Rensselæria ovalis*, Hall. Oriskany sandstone, N. Y.

* III, 2, m, 9. *Rensselæria ovoides*, Hall. Oriskany sandstone, N. Y.

III, 2, m, 10. *Rensselæria ovoides*, Hall. Oriskany sandstone, N. Y.

III, 2, m, 11. Missing.

III. 2, m, 12. "Anomites in argillite," *Liorhynchus limitaris.* Marcellus shale, N. Y.

III, 2, m, 13. "Anomites in limestone, Fairfield, Herkimer county," *Orthis testudinaria.* Trenton limestone, N. Y.

* III, 2, m, 14. *Rensselæria ovoides*, Hall. Oriskany sandstone, N. Y.

III, 2, m, 15. Missing.

* III, 2, m, 16. *Strophomena deltoidea*, Conrad. Trenton limestone, Eastern N. Y.

III, 2, m, 17. Missing.

III, 2, m, 18. *Rhynchonella.* Hamilton group, Albany county? N. Y.

III, 2, m, 19. *Strophomena deltoidea*, Conrad. Trenton limestone, Eastern N. Y.

III, 2, m, 20. *Leptæna* sp.? Trenton limestone, N. Y.

III, 2, m, 21. *Pentamerus galeatus.* Lower Helderberg group, N. Y.

III, 2, m, 22. *Rhynchonella.* Chalk flint, England.

III, 2, n, 1. Missing.

III, 2, n, 2. "Gryphite, Bethlehem," *Pentamerus galeatus.* Lower Helderberg group, N. Y.

III, 2, n, 3. "Gryphite, Helderberg," *Pentamerus galeatus.* Lower Helderberg group, N. Y.

III, 2, n, 4. "Gryphite, Helderberg," *Pentamerus galeatus.* Lower Helderberg group, N. Y.

III, 2, n, 5. "Gryphite, Helderberg," *Pentamerus galeatus.* Lower Helderberg group, N. Y.

* III, 2, o, 1. "Terebratulite, Helderbergh," *Spirifer arrectus*, Hall. Oriskany sandstone.

III, 2, o. 2. "Terebratulites, Coeymans," *Spirifer mucronatus*, Conr. Hamilton group.

III, 2, o, 3. "Terebratulites, Rensselaerville," *Tropidoleptus carinatus*, Hall. Hamilton group.

III, 2, o, 4. "Inside of a Terebratulite, Bethlehem," *Hipparionyx proximus*, Vanuxem. Oriskany Sandstone.

III, 2, o, 5. *Spirifer arrectus*, Hall. Oriskany sandstone.

III, 2, o, 6. "Terebratulite, Helderbergh," Spirifer arenosus, Hall. Oriskany sandstone.

III, 2, o, 7. "Terebratulites in Greywacke, Coeymans," *Rhynchonella.* Hamilton group, N. Y.

* III, 2, o, 8. *Spirifer arenosus*, Hall. Oriskany Sandstone, Albany county, N. Y.

III, 2, o, 9. *Hipparionyx proximus*, Vanuxem. Oriskany Sandstone, Albany county, N. Y.

* III, 2, o, 10. *Hipparionyx proximus*, Vanuxem. Oriskany Sandstone, Albany county, N. Y.

* III, 2, o, 11. *Hipparionyx proximus*, Vanuxem. ORIGINAL. Oriskany sandstone, Albany county, N. Y.

III, 2, o, 12. Missing.

III, 2, o, 13. Missing.

III, 2, o, 14. Missing.

III, 2, o, 15. *Spirifer.* Chemung group, N. Y.

III, 2, o, 16. Missing.

III, 2, o, 17. *Zygospira erratica*, Hall, etc. Hudson River group, Central N. Y.

III, 2, p, 1. "Mytilite, West. Dist." *Grammysia arcuata*, Hall. Hamilton group, N. Y.

III, 2, p, 2. *Modiolopis modiolaris.* Hudson River group, Central N. Y.

III, 2, p, 3. *Ambonychia radiata.* "From the high grounds bordering Salmon River, two or three miles from the present shore of Lake Ontario, Oswego co."

III, 2, p, 4. *Lingula cuneata.* Medina standstone, Albion, N. Y.

III, 2, p, 5. *Actinopteria decussata.* Hall. Hamilton group, N. Y.

III, 2, p, 6. *Goniophora Hamiltonensis.* Hamilton group, N. Y.

III, 3, a, 1. *Nautilus.* Triassic, Europe.

III, 3, a, 2. *Ammonites.* Triassic, Europe.

III, 2, p, 8. *Crassatella.* Jurassic, Europe.

III, 2, p, 9. *Crassatella.* Jurassic, Europe.

III, 3, b, 1. *Ammonites.* Jura, Solenhofen?

III, 3, b, 2. *Gyroceras trivolve.* Hall. Corniferous limestone, Schoharie, N. Y.

*III, 3, b, 3. *Gyroceras trivolve* (3 specimens). Corniferous limestone, Schoharie, N. Y.

*III, 3, b, 4. *Gyroceras trivolve* (2 specimens). Corniferous limestone, Schoharie, N. Y.

III, 3, b, 5. *Ammonites.* Jurassic, England.

III, 3, b, 6. *Ammonites* (2 specimens). Jurassic, England.

III, 3, b, 7. *Ammonites.* Jurassic, England.

III, 3, b, 8. *Ammonites.* Jurassic, England.

III, 3, b, 9. *Ammonites.* Jurassic, England.

III, 3, b, 10. *Ammonites.* Jurassic, England.

*III, 3, b, 11. *Goniatites Vanuxemi.* Hall. Goniatite limestone, Schoharie, N. Y.

III, 3, b, 12. *Ammonites.* Jurassic, Europe.

III, 3, b, 13. *Ammonites.* Jurassic, Europe.

III, 3, b, 14. *Ammonites.* Jurassic, Europe.

III, 3, b, 15. *Ammonites.* Jurassic, Europe.

III, 3, b, 16. *Ammonites.* Jurassic, Europe.

III, 3, b, 17. *Ammonites.* Jurassic, Europe.

III, 3, b, 18. *Ammonites.* Jurassic, Europe.

*III, 3, b, 19. *Lituites convolvans.* Hall. ORIGINAL (Palæontology of New York, vol. 1, pl. 13, fig. 2*a*). Black River limestone, Watertown, N. Y.

*III, 3. d, 1. *Endoceras longissimum.* Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 2. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

III, 3, d, 3. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

III, 3, d, 4. *Endoceras proteiforme.* Hall. Trenton limestone, N. Y.

III, 3, d, 5. *Endoceras proteiforme.* Hall. Trenton limestone, N. Y.

III, 3, d, 6. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

III, 3, d, 7. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 8. *Endoceras.* Black River limestone, Watertown, N. Y.

*III, 3, d, 9. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 10. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 11. *Endoceras.* Black River limestone, Watertown, N. Y.

*III, 3, d, 12. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 13. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 14. *Ormoceras tenuifilum.* ORIGINAL. (Palæontology of New York, vol. I, pl. 15, figs. 1, 1*a*, 16, plate 16, fig. 1*a*). Black River limestone, Watertown, N. Y.

III, 3, d, 15. *Endoceras proteiforme.* Hall. Trenton limestone N. Y.

III, 3, d, 16. *Endoceras proteiforme.* Hall. Trenton limestone, N. Y.

*III, 3, d, 17. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 17. *Ormoceras tenuifilum.* Hall. Black River. ?North shore of Lake Huron.

*III, 3, d, 18. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 19. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 20. *Orthoceras* sp.? Hamilton group, Central N. Y.

III, 3, e, 1. Missing.

III, 3, e, 2. Missing.

III, 3, e, 3. Missing.

III, 3, e, 4. *Belemnites.* Locality ?

III, 3, e, 5. *Belemnites.* Locality ?

III, 3, e, 6. Missing.

III, 3, e, 7. "Belemnites. Pennsylvania."

III, 3, k, 1. "Buccinite Helderbergh." *Loxonema* sp.? Lower Helderberg limestone.

III, 3, n, 1. "Turbinite Helderbergh." *Platystoma* sp. ? Schoharie grit.

III. 3, n, 2. "Turbinite Helderbergh." *Platystoma* sp. ? Schoharie grit.

III, 3, n, 3. *Maclurea* sp. Chazy limestone, N. Y.

III, 3, n, 4. *Platystoma* sp. ? Coniferous limestone, N. Y.

III, 3, n, 5. *Platyceras* sp. ? Schoharie grit, N. Y.

III, 3, n, 6. *Platyceras spirale* Hall. Lower Helderberg group, N. Y.

*III, 3, n, 7. *Lituites undatus*, Hall. ORIGINAL. (Palæontology of New York, vol. I, pl. 13, pp. 1a, 1b.) Black River limestone, Watertown, N. Y.

III, 3, n, 8. *Platystoma.* Corniferous limestone, N. Y.

III, 3, n, 9. Missing.

III, 3, n, 10. *Pleurotomaria sulcomarginata*, Hall. Hamilton group, Central N. Y.

III, 3, q, 1. *Leptæna rhomboidalis.* Locality ?

III, 3, q, 2. *Leptæna rhomboidalis* var. *ventricosa*, Hall. Oriskany limestone, N. Y.

III, 3, q, 3. *Leptæna rhomboidalis.* Coniferous limestone, N. Y.

III, a, a, 1. *Baculites.* Cretaceous. Locality?

III. a, 10. *Spirifer arrectus,* Hall. Oriskany sandstone. the Helderberg, N. Y.

IV, a, 1. *Halysites catenulata.* Niagara group, N. Y.

IV, a, 2. Missing.

IV, a, 3. *Eridophyllum.* Niagara group, N. Y.

IV, a, 4. *Syringopora.* Niagara group, Western N. Y.

IV, a, 5. Missing.

IV, a, 6 (2 specimens). *Columnaria alveolata.* Black River limestone, Eastern N. Y.

IV, b, 1. *Zaphrentis.* Corniferous limestone, Helderberg.

IV, b, 2. *Zaphrentis.* Corniferous limestone, Helderberg.

IV, b, 3. *Zaphrentis.* Corniferous limestone, Helderberg.

IV, b, 4. *Zaphrentis.* Corniferous limestone, Helderberg.

IV, b, 5. *Zaphrentis.* Corniferous limestone, Helderberg.

IV, b, 6. *Zaphrentis.* Corniferous limestone, Helderberg.

IV, b, 7. *Zaphrentis.* Corniferous limestone, Helderberg.

IV, b, 8. *Zaphrentis.* Corniferous limestone, Helderberg.

IV, b, 9. *Heliophyllum.* Corniferous limestone, Helderberg.

IV, b, 10. *Atrypa reticularis.* Corniferous limestone, Helderberg.

IV, b, 11. "Inside of a Cornua-Madreporite, Bethlehem." *Zaphrentis.* Schoharie Grit, N. Y.

IV, b, 12. *Heliophyllum.* Corniferous limestone, N. Y.

IV, b, 13. *Streptelasma rectum,* Hall. Hamilton group, Lake Erie.

IV, b, 14. *Heliophyllum.* Corniferous limestone, N. Y.

IV, b, 15. *Zaphrentis.* Corniferous limestone, N. Y.

IV, b, 16. *Zaphrentis.* Corniferous limestone, N. Y.

IV, b, 17. *Zaphrentis.* Corniferous limestone, N. Y.

IV, b, 18. *Pecten.* Tertiary locality. ?

IV, b, 19. Missing.

IV. b, 20. *Heliophyllum Halli,* E. & H. Hamilton group, Western N. Y.

IV, b, 21. Missing.

IV, b, 22. Water worn corals. Hamilton group, N. Y.

IV, b, 23. Coral. Probably European Jurassic.

*IV, b, 24. *Heliophyllum.* Corniferous limestone, N. Y.

IV, b, 25. *Favosites & Zaphrentis.* Corniferous limestone, N. Y.

IV, b, 26. Missing.

IV, b, 27. Organic Impressions. Clinton group (Gray band), Medina, N. Y.

IV, b, 28 (2 specimens). *Zaphrentis.* Corniferous limestone, N. Y

IV, b, 29. Missing.
IV, b, 30. Bryozoa. Trenton limestone, Central N. Y.
IV, b, 31. Bryozoa. Trenton limestone, Central N. Y.
IV, b, 32. *Heliophyllum.* Hamilton group, Western N. Y.
IV, b, 33. *Zaphrentis.* Corniferous limestone, Western N. Y.
IV, b, 34. Missing.
IV, b, 35. *Monticulipora lycoperdon.* Trenton limestone, N. Y.
IV, f, 1. *Favosites.* Corniferous limestone, Helderberg, N. Y.
IV, f, 2. *Favosites.* Corniferous limestone, Bethlehem, N. Y.
IV, f, 3. *Columnaria alveolata.* Black River limestone, N. Y.
IV, f, 4. *Favosites.* Corniferous limestone, Bethlehem, N. Y.
IV, f, 5. *Favosites.* Corniferous limestone, N. Y.
IV, f, 6. *Favosites.* Corniferous limestone, N. Y.
IV, f, 7. *Favosites.* Corniferous limestone, N. Y.
IV, f, 8. *Favosites.* Corniferous limestone, N. Y.
IV, f, 9. *Favosites.* Corniferous limestone, N. Y.
IV, f, 10. *Favosites.* Corniferous limestone.
IV, f, 11. *Favosites.* Niagara limestone.
IV, f, 12. *Favosites.* Corniferous limestone, N. Y.
IV, f, 13. *Favosites.* Corniferous limestone, N. Y.
IV, f, 14. *Favosites.* Corniferous limestone, N. Y.
IV, f, 15. *Favosites.* Corniferous limestone, N. Y.
IV, f, 16. *Favosites.* Niagara limestone, N. Y.
IV, f, 17. Missing.
IV, f, 18. Missing.
IV, f, 19. (3 specimens.) *Favosites.* Niagara limestone, N. Y.
IV, f, 20. Missing.
IV, f, 21. Missing.
IV, f, 22. *Zaphrentis.* Corniferous limestone, N. Y.
IV, f, 23. Missing.
IV, f, 24. *Favosites.* Niagara limestone, N. Y.
IV, f, 25. (2 specimens.) Niagara?
IV, f, 26. *Favosites.* Niagara limestone. Illinois and Wisconsin.
IV, g, 1. Graptolites. Hudson River slates? N. Y.
IV, k, 1. *Eridophyllum.* Corniferous limestone, Berne, N. Y.
IV, k, 2. *Eridophyllum.* Corniferous limestone, Berne, N. Y.
IV, k, 3. *Columnaria alveolata.* Trenton limestone, N Y.
IV, k, 4. *Columnaria alveolata.* Trenton limestone Glens Falls, N. Y.
IV, k, 5. *Columnaria alveolata.* Trenton limestone, Glens Falls, N. Y.

IV, k, 6. *Trachypora.* Corniferous limestone, N. Y.
IV, l, 1. *Syringopora.* Corniferous limestone, Bethlehem, N. Y.
IV, l, 2. *Syringopora.* Corniferous limestone, N. Y.
IV, m, 1. Sponge. Chalk, Wilts, England.
IV, r, 16. *Favosites.* Corniferous limestone, N. Y.
IV, r, 25. *Stromatopora.* Niagara limestone, N. Y.
V, 1. Missing.
V, 2. Water-worn coral.
V, 3. "Veget. Petrefact. in Hornstone. Coeymans." *Trematopora.* Delthyris shaly limestone.
V, 4. "Veget. Petrefact. Helderbergh." Casts of sponge tubes. Oriskany sandstone.
V, 5. "Veget. Petrefact. Helderbergh." Casts of sponge tubes. Oriskany sandstone.
V, 6. Missing.
V, 7. Epsomites. Niagara limestone, N. Y.
V, 8. Epsomites. Niagara limestone, N. Y.
V, 9. Epsomites. Niagara limestone, N. Y.
V, 10–12. Missing.
V, 13. Travertine. Danube, Herkimer county, N. Y.
V, 14–30. Missing.
V, 31. Silicified palm. Locality?
V, 32, 33. Missing.
V, 34. "Ferruginified birch roots. Fowler. St. Lawrence county."
V, 35. Missing.
V, 36. (2 specimens) *Orthoceras* sp.? Marcellus shales, Schoharie, N. Y.
V, 37, 38. Missing.
*V, 39. "*Lithodictuon Beckii,* from Medina, Orleans county, N. Y. (Grey band of Eaton.) Dr. G. W. Boyd."
V, 40, 41. Missing.
V, 42. *Arthophycus Harlani.* (3 specimens.) Medina, N. Y.

1. *Trigonia,* etc. Jurassic. Locality?
2. *Trigonia,* etc. Jurassic. Locality?
4. *Triarthrus Becki.* Green. Utica slate, N. Y.
4. *Orbiculoidea grandis.* Van. Hamilton group, Central N. Y.
4. *Streptelasma,* etc. Hamilton group, Western N. Y.
5. Corniferous limestone, N. Y.
5. *Scolithus.* Potsdam sandstone, N. Y.

*6+20+21+26. *Endoceras longissimum.* Hall. ORIGINAL. (Palæontology of New York, vol. I, pl. 18, figs. 1, 1a.) Black River limestone, Watertown, N. Y.

*7. *Gonioceras anceps.* Hall. Black River limestone, Watertown, N. Y.

8. *Murchisonia bellicincta.* Trenton limestone, Central N. Y.

9. *Murchisonia bellicincta.* Trenton limestone, Central N. Y.

10. *Edmondia subtruncata.* Hall. Trenton limestone, Central N. Y.

10. *Orthoceras,* Schoharie grit, N. Y.

11+13. *O. junceum,* Hall. Trenton limestone, Central N. Y.

12. *Edmondia subtruncata,* Hall. Trenton limestone, Central N. Y.

14. *Monticulipora.* Trenton limestone, Central N. Y.

15. *M. lycoperdon.* Trenton limestone, Central N. Y.

*16+23. *Gonioceras anceps,* Hall. Black Biver limestone, Watertown, N. Y.

18. *Monticulipora.* Trenton limestone, N. Y.

*19. *Gonioceras anceps,* Hall. Black River limestone, Watertown, N. Y.

21. Pentamerus limestone, Rochester, N. Y.

*22. *Ormoceras ? gracile,* Hall. ORIGINAL. (Palæontology of New York, vol. 1, pl. 17, fig. 3.) Black River limestone, Watertown, N. Y.

25. *Stromatocerium rugosum,* Hall. Watertown, N. Y.

26. *Tetradium.* Watertown, N. Y.

27. *Stromatocerium rugosum,* Hall. Watertown, N. Y.

*28. *Endoceras proteiforme,* var. *tenuistriatum,* Hall. Trenton limestone, Central N. Y.

29. *Edmondia subtruncata,* Hall. Trenton limestone, Central N. Y.

31. *Pterinea flabella,* Conr. Hamilton group, Central N. Y.

45. *Spirifer arrectus,* Conr. Oriskany sandstone, N. Y.

136. *Halysites catenulata.* Niagara group, N. Y.

SPECIMENS WITH PRINTED NUMBERS.

445, 471, 502. *Spirifer mesastrialis,* Hall. *Modiomorpha* and other fossils. Chemung group, N. Y.

58, 376, 424. *Limoptera macroptera,* Conr. Hamilton group, N. Y.

53. *Spirifer.* Lower Carboniferous. Locality?

119. *Heliophyllum Halli,* E. & H. Hamilton group, Western N. Y.

72, 304. *Orthoceras.* Hamilton group, Central N. Y.

444, 454, 81, 464. *Spirifer granulosus,* Conr. Hamilton group, Central N. Y.

43. *S. audaculus*, Conr. Hamilton group, Central N. Y.
71. *Cimitaria recurva*, Conr. Hamilton group, Central N. Y.
84. *Spirifer mucronatus*, Conr. Hamilton group, Rensselaerville, N. Y.
22. *Favosites.* Niagara group, N. Y.
*a. Potsdam sandstone, N. Y.
b. *Pholadomya.* Jurassic, Europe.
b. *Zaphrentis.* Corniferous limestone, N. Y.
c. *Cucullœa.* Cretaceous, Europe.
c. *Columnaria.* Black River limestone, N. Y.
d, f. *Monticulipora lycoperdon.* Trenton limestone, N. Y.
*e. *Orthoceras nuntium*, Hall. Hamilton group, Central N. Y.
k. *Leptœna rhomboidalis*, Wilck. Corniferous limestone, N. Y.
0.1 ? Corniferous, Ky.
0.3. ? Corniferous, Ky.

t, u, v. Various fossils. Hudson River group (erratic blocks), N. Y.
a, a. (Two specimens) *Monticulipora lycoperdon.* Trenton limestone, N. Y.
*b, b. *Tentaculites gyracanthus*, Eaton. Tentaculite limestone, Schoharie, N. Y.
c, c. *Grammysia arcuata*, Conr. Hamilton group, N. Y.
d, d. Cetacean ? bones. Locality ?
e, e. Silicified wood. Locality ?
f, f. *Batrachoides nidificans*, Hitchcock. Triassic sandstone, Connecticut Valley, Mass.
g, g. Various fossils. Hamilton group, N. Y.
h, h. *Orthoceras undulatum*, Hall. Niagara limestone, Western New York.
o, o. *O. Marcellense*, Hall. Goniatite limestone, Schoharie, N. Y.
N. 1. *Conocardium trigonale*, Conr. Corniferous limestone, Schoharie, N. Y.?
N. 2. *Leperditia alta*, Conr. Tentaculite limestone, Schoharie, N. Y.
N. 3. Corniferous limestone, Schoharie, N. Y.
*N. 4. *Favosites tuberosa*, Rom. Corniferous limestone, Schoharie, N. Y.
N. 5. *Zaphrentis.* Corniferous limestone, Schoharie, N. Y.
N. 6. *Favosites.* Corniferous limestone, Schoharie, N. Y.
N. 7. *Platyceras dumosum*, Conr. Corniferous limestone, Schoharie, harie, N. Y.
N. 8. *Megambonia bellistriata*, Hall. Oriskany limestone, Schoharie, N. Y.

*N. 9. *Terebratula?* Corniferous limestone, Schoharie, N. Y.
*N. 10. *Ptilodictya.* Corniferous limestone, Schoharie, N. Y.
N. 11. *Favosites tuberosa*, Rom. Corniferous limestone, Schoharie, N. Y.
N. 12. *Favosites.* Corniferous limestone, Schoharie, N. Y.?
N. 13. *Pterinœa arenaria*, Hall. Oriskany sandstone, Schoharie, N. Y.
E. 3. Fish tooth. Locality ?
E. 4. Fish tooth. Locality ?
E. 7. Fish tooth. Locality ?
E. 6. Fish tooth. Locality ?
E. 9. Fish tooth. Locality ?
G. *Trinucleus concentricus.* Trenton limestone, N. Y
G. Hamilton group ?
H. *Trinucleus concentricus.* Trenton limestone, N. Y.
I. *Leptœna rhomboidalis.* Corniferous limestone, N. Y.
I. *Edmondia subtruncata*, Hall. Trenton limestone, N. Y.
L. ? ?
M. ? ?
P. 1. Pentamerus limestone. Clinton group. Western, N. Y.
P. 2. *Spirifer granulosus*, Conr. Hamilton group, N. Y.
P. 3. *Conocardium.* Corniferous limestone, N. Y.
P. 4.
P. 5. *Limoptera?* Hamilton group, N. Y.
P. 6. *Spirifer granulosus*, Conr. Hamilton group, N. Y.
P. 7. *Orthoceras crotalum*, Hall. Hamilton group, N. Y.
S. *Pentamerus oblongus*, Hall. Clinton group, Rochester, N. Y.
X. *Astarte.* Cretaceous. Locality. ?

FOSSILS WITHOUT LABELS OR TICKETS.

Columnaria alveolata (2 specimens). Black River limestone, N. Y.
Bellerophon bilobatus Conr. Trenton limestone, N. Y.
Raphistoma lenticulare. Trenton limestone, N. Y.
Orthis biforata Eich. Hudson River group, Ohio.
Ambonychia radiata. Hudson River group, N. Y.
Cyrtolites ornatus. Hudson River group, N. Y.
**Pleurotomaria ? pervetusta*, Hall. Medina sandstone, N. Y.
Pentamerus oblongus var. Niagara group, Iowa.
Caryocrinus ornatus, Hall (2 specimens). Niagara group, Lockport, N. Y.
Spirifer Niagarensis, Hall. Niagara group.

Halysites catenulata. Niagara group, N. Y.

Epsomites. Niagara group, N. Y.

Spirifer macropleura, Conrad. Lower Helderberg group, N. Y.

Meristella lævis, Hall. Lower Helderberg group, N. Y.

Leperditia alta, Conrad. Lower Helderberg group, N. Y.

Pentamerus galeatus, Dal. Lower Helderberg group, N. Y.

Spirifer arenosus, Conr. Oriskany sandstone, N. Y.

S. arrectus, Hall (2 specimens). Oriskany sandstone, N. Y.

Rensselæria ovoides, Hall (3 specimens). Oriskany sandstone, N. Y.

R. ovalis, Hall. Oriskany sandstone, N. Y.

Eatonia peculiaris, Hall (2 specimens). Oriskany sandstone, N. Y.

Orthoceras. Schoharie grit, N. Y.

Atrypa reticularis (19 specimens). Corniferous limestone, N. Y.

One lot corals (15 specimens). Corniferous limestone, N. Y.

Athyris spiriferoides Eaton (34 specimens). Hamilton group, Western N. Y.

One misc. lot brachiopods (15 specimens). Hamilton group, Western N. Y.

Grammysia alveata. Hamilton group, Western N. Y.

Cimitaria recurva. Hamilton group, Western, N. Y.

Limoptera macroptera (2 specimens). Hamilton group, Western N. Y.

One lot corals (10 specimens). Hamilton group, Western N. Y.

Misc. brachiopods (4 specimens). Chemung group, N. Y.

One lot Tertiary fossils. Locality?

One lot carboniferous plants from Carbondale, Pittston, Plymouth, etc., Penna. (58 specimens).

One lot carboniferous plants from Morgan county, Virginia.

Palæoniscus, Trias. Turner's Falls, Mass.

Skeleton of fish (2 specimens). Solenhofen, Germany.

Favosites. Niagara limestone, N. Y.

* *Orthoceras arcuoliratum*, Hall. Trenton limestone, Wisconsin.

Report of the Assistant Palæontologist.

Albany, New York, *September* 30, 1891.

James Hall, LL. D., *State Geologist.*

Sir.— Early in the present year I received instructions to devote my time as far as possible to the requirements of the Palæontology of New York; as a necessary consequence museum work among the palæontological collections has progressed but little during the past year. The mounting of the crustacean collection has been advanced beyond its condition at date of last report, but still lacks considerably of completion. Important additions have, however, been made to the collections, and of these a list is communicated with this report. Opportunity for field work has been curtailed by the heavy expenditure connected with the geological investigations carried on at the Livonia salt shaft, which has been borne entirely by this department. We have received from Mr. D. D. Luther, who has conducted these investigations, one shipment of specimens, consisting of nineteen boxes and one barrel of fossils, mostly from the upper layers of the Hamilton shales, and a second lot of nine boxes from the middle part of this formation. At the time Mr. Luther began his work in May last, the excavation of the shaft had proceeded to a depth of about 350 feet; of this thickness about 125 feet pertained to the Hamilton shales, the rock section from 225 feet upward being wholly in the Genesee shales. The latter have furnished but the few, common species of the dark shales, the *styliola limestone* layer, which appears in the sections further to the east, being here represented by a few isolated concretions of small size. The fossils of the upper Hamilton shales collected from the dump of the shaft, representing the section from 225–350 feet, have been examined and identified by me, and a list of these with the other fossils of this series of formations will be submitted when a final report on this interesting section shall be rendered. The material thus far examined has been found very rich in trilobites, linguloids and lamellibranchs; the linguloids especially being remarkable for their diversity of form and beauty of preservation.

Late in the autumn of last year Mr. Jacob Van Deloo made some collections of fossils from the Chazy limestone at Keeseville, and in September of this year he, with Mr. Martin Sheehy, collected considerable valuable material from the interesting Oriskany fauna on Becraft's Mountain, near Hudson, discovered last year by Dr. C. E. Beecher of New Haven.

About a year ago I began the preparation of a series of lists of the type and illustrated specimens of fossils belonging to the Museum collections. The lists heretofore published have been fragmentary and scattered; it has been my purpose to bring together in a zoological arrangement an enumeration, complete to date, of these important specimens, with citations to the publications in which they have been figured. I transmit herewith the first installment of this catalogue, viz., Part I, *Crustacea.*

The work done on the Palæontology of New York, vol. VIII, parts 1 and 2, is fully recounted in your own report.

I am, sir, very respectfully yours.

J. M. CLARKE,
Assistant Palæontologist.

DEPARTMENT OF GEOLOGY AND PALÆONTOLOGY.

List of the Original and Illustrated Specimens in the Palæontological Collections

PART I.----CRUSTACEA.

Prepared by JOHN M. CLARKE, Assistant Palæontologist.

1891. 8

PREFATORY NOTE.

The fundamental arrangement in this list is a zoological one; the subordinate arrangement of species under genera is chronological. The combinations of generic and specific names are those adopted in the work where the species have been most fully discussed and illustrated. For the classification of the genera, however, the writer is alone responsible. The collections of the Museum include a considerable number of reproductions in plaster-of-paris, gutta-percha and sulphur, of original specimens, and these are, for convenience of reference, included in the list, but the citations of these are marked with an asterisk (*) in the margin of the page. The actual original specimens, including those used for the first illustration of the species, are indicated by having the reference to the illustration in heavy-face type.

OSTRACODA.

Family LEPERDITIDÆ.

Genus LEPERDITIA, Rouault. 1851.

Leperditia Hudsonica, Hall. 1859.

Palæontology of New York, vol. iii, p. 375.

Quarterly Journal of the Geological Society, vol. xlvi, pl. 1, figs. **5, a, b, c.**

Lower Helderberg group (Shaly limestone). Becraft's Mountain, N. Y.

Leperditia alta, Conrad (sp.). 1843.

In Vanuxem's Report on the Third Geological District of New York, p. 112.

Quarterly Journal of the Geological Society, vol. xlvi, pl. 1, figs. 6, a, b.

Lower Helderberg group (Tentaculite limestone). Herkimer county, N. Y.

Genus BEYRICHIA, McCoy. 1844.

Beyrichia trisulcata, Hall. 1859.

Palæontology of New York, vol. iii, p. 381.

Quarterly Journal of the Geological Society, vol. xlvi, pl. 1, fig. **2.**

Lower Helderberg group (Tentaculite limestone). Herkimer county, N. Y. *J. Gebhard purchase.*

Beyrichia granulata, Hall. 1859.

Palæontology of New York, vol. iii, p. 377.

Quarterly Journal of the Geological Society, vol. xlvi, pl. 1, fig. **3.**

Lower Helderberg group (Pentamerus limestone). Schoharie county, N. Y. *J. Gebhard purchase.*

Beyrichia oculina, Hall. 1859.

Palæontology of New York, vol. iii, p. 378.

Quarterly Journal of the Geological Society, vol. xlvi, pl. 1, fig. **4.**

Lower Helderberg group (Pentamerus limestone). Schoharie county, N. Y. *J. Gebhard purchase.*

Beyrichia parasitica Hall, (sp.). 1859.

Palæontology of New York, vol. iii, p. 376.

Quarterly Journal of the Geological Society, vol. xlvi, p. 17, fig. 1.

Lower Helderberg group (Tentaculite limestone). Herkimer county, N. Y. *J. Gebhard purchase.*

Beyrichia Clarkii, Jones. 1890.

Quarterly Journal of the Geological Society, vol. xlvi, p. 17, fig. 2.

Lower Helderberg group (Tentaculite limestone). Herkimer county, N. Y. *J. Gebhard purchase.*

Beyrichia subquadrata, Jones. 1890.

Quarterly Journal of the Geological Society, vol. xlvi, p. 537, pl. xx, fig. 4.

Corniferous limestone (drift). Canandaigua, N. Y.

J. M. Clarke purchase.

Beyrichia Klœdeni, McCoy. var.

Quarterly Journal of the Geological Society, vol. xlvi, p. 538, pl. 21, fig. 1a, b.

Corniferous limestone (drift). Canandaigua, N. Y.

J. M. Clarke purchase.

Beyrichia Kolmodini, Jones. 1890.

Quarterly Journal of the Geological Society, vol. xlvi, p. 538, pl. 20, fig. 6.

Hamilton group. Clarke county, Indiana.

J. M. Clarke purchase.

Genus PRIMITIA, Jones and Holl, 1865.

Primitia Clarkii, Jones. 1890.

Quarterly Journal of the Geological Society, vol. xlvi, p. 535, pl. 21, fig. 11.

Corniferous limestone (drift). Canandaigua, N. Y.

J. M. Clarke purchase.

Genus KLŒDENIA, Jones and Holl. 1886.

Klœdenia notata, Hall (sp.), var. *ventricosa*, Hall. 1859.

Palæontology of New York, vol. iii, p. 380.

Quarterly Journal of the Geological Society, vol. xlvi, p. 14, pl. 1, figs. 1, a, b.

Lower Helderberg group (Shaly limestone). Herkimer county, N. Y.

J. Gebhard purchase.

Genus **BOLLIA**, Jones and Holl. 1886.

Bollia bilobata, Jones. 1890.

Quarterly Journal of the Geological Society, vol. xlvi, p. 540, pl. 20, fig. 12.

Corniferous limestone (drift). Canandaigua, N. Y.

J. M. Clarke purchase.

Genus **MOOREA**, Jones and Kirby.

Moorea Kirbyi, Jones. 1890.

Quarterly Journal of the Geological Society, vol. xlvi, p. 542, pl. 20, fig. 9, a, b.

Corniferous limestone (drift). Canandaigua, N. Y.

J. M. Clarke purchase.

Genus **OCTONARIA**, Jones.

Octonaria Linnarssoni, Jones. 1890.

Quarterly Journal of the Geological Society, vol. xlvi, p. 541, pl. 20, fig. 7, a, b.

Hamilton group. Clarke county, Indiana.

J. M. Clarke purchase.

Genus **EURYCHILINA**, Ulrich.

Eurychilina reticulata, Ulrich (Jones. 1890).

Quarterly Journal of the Geological Society, vol. xlvi, p. 539, pl. 20. fig. 13, a, b.

Corniferous limestone (drift). Canandaigua, N. Y.

J. M. Clarke purchase.

CIRRIPEDIA.

Family LEPADIDÆ.

Genus TURRILEPAS, Woodward. 1865.

Turrilepas flexuosus, Hall. 1888.

Palæontology of New York, vol. vii, p. 215, pl. 36, fig. **1**.
Corniferous chert. Canandaigua, N. Y.
J. M. Clarke purchase.

Turrilepas cancellatus, Hall. 1888.

Palæontology of New York, vol. vii, p. 216, pl. 36, fig. **2**.
Corniferous chert. Canandaigua, N. Y.
J. M. Clarke purchase.

Turrilepas devonicus, Clarke. 1882.

American Journal of Science, vol. xxiv, p. 55, fig. **1**.
Palæontology of New York, vol. vii, 1888, pl. 36, fig. **3**.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Turrilepas squama, Hall. 1888.

Palæontology of New York, vol. vii, p. 217, pl. 36, fig. **5**.
Palæontology of New York, vol. vii, pl. 36, fig. **6**.
Palæontology of New York, vol. vii, pl. 36, fig. **7**.
Palæontology of New York, vol. vii, pl. 36, fig. **8**.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase

Turrilepas foliatus, Hall. 1888.

Palæontology of New York, vol. vii, p. 218, pl. 36, fig. **15**.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase

Turrilepas nitidulus, Hall. 1888.

Palæontology of New York, vol. vii, p. 218, pl. 36, fig. **4**.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase

Turrilepas tener, Hall. 1888.

Palæontology of New York, vol. vii, p. 219. pl. 36, figs. **9, 10, 11, 12, 13.**
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, pl. 36, fig. **14.**
Hamilton group, Canandaigua lake, N. Y.
J. M. Clarke purchase.

Turrilepas ? Newberryi, Whitfield. 1882.

Annals N. Y. Academy of Sciences, vol. ii, no. 8, p. 217.

*Palæontology of New York, vol. vii, pl. 36, fig. **17.**
*Palæontology of New York, vol. vii, pl. 36, fig. **19.**
Erie shale. Sheffield, Ohio.

Genus STROBILEPIS, Clarke. 1888.

Strobilepis spinigera, Clarke. 1888.

Palæontology of New York, vol. vii, p. 212, pl. 36, figs. **20, 21, 22.**
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1861.

Family BALANIDÆ.

Genus PALÆOCREUSIA, Clarke. 1888.

Palæocreusia devonica, Clarke. 1888.

Palæontology of New York, vol. vii, p. 210, pl. 36, figs. **24, 25, 26.**
Corniferous limestone. LeRoy, N. Y.
Collected by C. D. Walcott and C. Van Deloo, 1878.

TRILOBITA.

Family NUTTAINIIDÆ.

Genus **NUTTAINIA**, Eaton. 1832.

**Nuttainia concentrica,* Eaton. 1832.

Monograph of the Trilobites of North America, p. 73. Cast No. **28.**
Trenton limestone. Near Waterford, N. Y.
The Albany Institute donor.

Family CALYMENIDÆ.

Genus **CALYMENE**, Brongniart. 1822.

** Calymene callicephala,* Green. 1832.

Monograph of the Trilobites of North America, p. 30. Cast No. **2.**
Hudson River group. Locality said to be Hampton, Virginia.
The Albany Institute donor.

*(*C. Blumenbachi* [Brongniart] Green).

Monograph of the Trilobites of North America, p. 28. Cast No. **1.**
Trenton limestone. Trenton Falls, N. Y.
The Albany Institute donor.

Calymene camerata, Conrad. 1842.

Journal Philadelphia Academy Natural Science, vol. viii. p. 278.

Palæontology of New York, vol. ii, 1852, pl. 78, fig. **1a.**
Niagara group (Coralline limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. ii, 1852, pl. 78, fig. **1b.**
Niagara group (Coralline limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. ii, 1852, pl. 78, figs. **1c, 1e.**
Niagara group (Coralline limestone). Schoharie, N. Y.
J. Gebhard purchase.

Calymene platys, Green. 1832.

Monograph Trilobites of North America, p. 32.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 1, fig. 3; and Palæontology of New York, vol. vii, 1888, pl. 1 fig. 1.

Schoharie grit. Schoharie, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 1, fig. 2; and Palæontology of New York, vol. vii, 1888, pl. 1, fig. 2.

Schoharie grit. Albany county, N. Y.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 1, figs. 4, 7, and Palæontology of New York, vol. vii, 1888, pl. figs. 3, 7.

Schoharie grit. Schoharie, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 1, fig. 5; and Palæontology of New York, vol. vii, 1888, pl. fig. 4.

Schoharie grit. Schoharie, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 1, fig. 6; and Palæontology of New York, vol. vii, 1888, pl. 1, fig. 5

Schoharie grit. Schoharie, N. Y.

Collected by C. Van Deloo. 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 1, fig. 1; and Palæontology of New York, vol. vii, 1888; pl. 1, fig. 6.

Schoharie grit. Knox, N. Y.

Collected by C. Van Deloo. 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 1, fig. 9; and Palæontology of New York, vol. vii, 1888, pl. 1, fig. 8.

Schoharie grit. Schoharie county, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 1, fig. 8; and Palæontology of New York, vol. vii, 1888, pl. 1, fig. 9.

Schoharie grit. Schoharie county, N. Y.

Genus **HOMALONOTUS**, Kœnig. 1825.

Sub-genus **TRIMERUS**, Green, 1832.

Homalonotus delphinocephalus, Green. 1832.

Monograph of the Trilobites of North America, p. 82, pl. 1, fig. **1**; original of Cast No. **32**.

Niagara group. "In limestone. Banks of Lake Ontario, Monroe county, N. Y."

The Albany Institute donor.

Monograph of the Trilobites of North America, p. 82; not figured.

Niagara group. Western New York.

The Albany Institute donor.

Palæontology of New York, vol. ii, 1852, pl. 68, fig. **9**.

Niagara group. Lockport, N. Y.

Homalonotus Vanuxemi, Hall. 1859.

Palæontology of New York, vol. iii, p. 352, pl. 73, fig. **12**.

Lower Helderberg group. Schoharie, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 5b, figs. 1, 2.

Lower Helderberg group. Kingston, N. Y.

L. Bevier, exchange.

Homalonotus major, Whitfield. 1885.

Bull. Amer. Mus. Nat. His. Vol. i, No. 6, p. 193, pl. 22.

Palæontology of New York, vol. vii, 1888, pl. 5a, fig. 1.

(Oriskany sandstone). Bank of 4th Binnewater, Rosendale, N. Y.

L. Bevier, exchange.

Subgenus **DIPLEURA**, Green. 1832.

Homalonotus DeKayi, Green (sp.). 1832.

Monograph of the Trilobites of North America, p. 80, not figured.

Hamilton group. Madison county, N. Y.

The Albany Institute donor.

(*) (*Nuttainia sparsa*, Eaton.)

Geological Text-book, 2nd ed., 1832, p. 34.

Monograph of the Trilobites of North America, p. 80, Cast No. **35**.

Hamilton group. Coeymans, N. Y.

The Albany Institute donor.

(*) Monograph of the Trilobites of North America, p. 79, Cast No. **31.**
Hamilton group. Northumberland, Pa. (?)

The Albany Institute donor.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 2, fig. 1; and Palæontology of New York, vol. vii, 1888, pl. 2, fig. 1.
Hamilton group. Madison county, N. Y.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 2, fig. 2; and Palæontology of New York, vol. vii, 1888, pl. 2, fig. 2.
Hamilton group. Ladd's quarry near Sherburne, Chenango county, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 2, fig. 6; and Palæontology of New York, vol. vii, 1888, pl. 2, fig. 6.
Hamilton group. Madison or Otsego county, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 2, fig. 7; and Palæontolgy of New York, vol. vii, 1888, pl. 2, fig. 7.
Hamilton group. Madison county, N. Y.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 2, figs. 8, 9; and Palæontology of New York, vol. vii, 1888, pl. 2, figs. 8, 9.
Hamilton group. Madison county, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 2, fig. 11; and Palæontology of New York, vol. vii, 1888, pl. 2, fig. 11.
Hamilton group. Darien, N. Y.

Collected by C. A. White and C. Van Deloo, 1860.

Illusfrations of Devonian Fossils, 1876; Crustacea, pl. 2, fig. 12; and Palæontology of New York, vol. vii, 1888, pl. 2, fig. 12.
Hamilton group. Cazenovia, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 3, fig. 1; and Palæontology of New York, vol. vii, 1888, pl. 3, fig. 1.
Hamilton group. Bellona, N. Y.

Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 3, fig. 2; and Palæontology of New York, vol. vii, 1888, pl. 3, fig. 2

Hamilton group. Near Leonardsville, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 3, fig. 3; and Palæontology of New York, vol. vii, 1888, pl. 3, fig. 3.

Hamilton group. Madison county, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 3, fig. 4; and Palæontology of New York, vol. vii. 1888, pl. 3, fig. 4.

Hamilton group. Canandaigua Lake, N. Y.

Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 3, fig. 5; and Palæontology of New York, vol. vii, 1888, pl. 3, fig. 5.

Hamilton group. Madison county, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 4, figs. 3, 4, 5; and Palæontology of New York, vol. vii, 1888, pl. 4, figs. 1, 2, 3.

Hamilton group. Madison county, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 4, fig. 6.

Hamilton group. Canandaigua Lake, N. Y.

J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 4, fig. 7.

Hamilton group. Canandaigua Lake. N. Y.

J. M. Clarke purchase.

Palæntology of New York, vol. vii, 1888, pl. 5, fig. 1.

Hamilton group. Pratt's Falls, N. Y.

Collected by C. Van Deloo and H. H. Smith, 1873.

Palæontology of New York, vol. vii, 1888, pl. 5, figs. 2, 3.

Hamilton group. Canandaigua Lake, N. Y.

J. M. Clarke purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 5, figs. 10, 9, and Palæontology of New York, vol. vii, 1888, pl. 5, figs. 12, 13.

Hamilton group. Hamilton, N. Y.

Collected by James Hall, 1862.

Family ASAPHIDÆ.

Genus BUMASTUS, Murchison.

Illænus Ioxus, Hall. 1867.

Twentieth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 378.

Eleventh Annual Report of the Department of Geology and Natural History (Indiana), 1882, pl. 33, fig. 13.
Niagara group. Waldron, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Eleventh Annual Report of the Department of Geology and Natural History (Indiana) 1882, pl. 33, fig. 14.
Niagara group. Waldron, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Illænus arcturus, Hall. 1847.

Palæontology of New York, vol. i, p. 23, pl. iv bis., fig. **12.**
Chazy limestone. Chazy, N, Y.
Geological Survey Collection.

Genus BATHYURUS, Billings. 1865.

Bathyurus extans, Hall. 1847.

Palæontology of New York, vol. i, p. 228, pl. lx, figs. **2, a, b.**
Birdseye limestone. Watertown, N. Y.
J. Gebhard purchase.

Genus ASAPHUS, Brongniart. 1822.

Asaphus obtusus, Hall. 1847.

Palæontology of New York, vol. i, p. 24, pl. iv bis., fig. **14.**
Chazy limestone. Chazy, N. Y.
Geological Survey Collection.

Asaphus canalis (Conrad), Hall. 1847.

Palæontology of New York, vol. i, p. 25, pl. iv bis., fig. **17.**
Chazy limestone. Chazy, N. Y.
Geological Survey Collection.

Palæontology of New York, vol. i, pl. iv bis., fig **19.**
Chazy limestone. Chazy, N. Y.
Geological Survey Collection.

Genus ISOTELUS, De Kay. 1824.

**Isotelus gigas*, De Kay. 1824.

Annals of the New York Lyceum of Natural History, vol. i, p. 124, pl. xiii, fig. **1**.
Trenton limestone. Trenton Falls, N. Y.
The Albany Institute donor.

Family BRONTEIDÆ.

Genus BRONTEUS, Goldfuss. 1843.

Bronteus Barrandii, Hall. 1859.

Palæontology of New York, vol. iii, p. 350, pl. 73, figs. **1, 2, 3, 4.**
Lower Helderberg group. Schoharie, N. Y.
J. Gebhard purchase.

Bronteus senescens, Clarke. 1889.

Eighth Annual Report N. Y. State Geologist, p. 57. fig. **1**.
Chemung group. Prattsburgh, N. Y.
J. M. Clarke donor.

Subgenus THYSANOPELTIS, Corda. 1847.

Bronteus Tullius, Hall. 1888.

Palæontology of New York, vol. vii, p. 12, pl. 8a., figs. **34, 35.**
Tully limestone. Kingsley's Hill, near Otisco, N. Y.
S. G. Williams donor.

Palæontology of New York, vol. vii, pl. 8a., fig. **36.**
Tully limestone. Borodino, N. Y.
S. G. Williams donor.

Family PHACOPIDÆ.

Genus PHACOPS, Emmrich. 1839.

Phacops Logani, Hall. 1859.

Palæontology of New York, vol. iii, p. 353, pl. 73, fig. **15**; and Palæontology of New York, vol. vii, 1888, pl. 8a., fig. **19.**
Lower Helderberg group. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, pl. 73, figs. **23, 24.**
Lower Helderberg group. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, pl. 8a., fig. 20.
Lower Helderberg group. Schoharie, N. Y.
J. Gebhard purchase.

Phacops cristata, Hall. 1861.

Descr. New Species Fossils, p. 67.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, figs. **1, 2**; and Palæontology of New York, vol. vii, 1888, pl. 6, figs. **1, 2.**
Schoharie grit. Knox, N. Y.
Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, figs. **3, 4**; and Palæontology of New York, vol. vii, 1888, pl. 6, figs. **3, 4.**
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, fig. **5**; and Palæontology of New York, vol. vii, 1888, pl. 6, fig. **5.**
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, figs. **9, 10**; and Palæontology of New York, vol. vii, 1888, pl. 6, figs. **6, 7.**
Schoharie grit. Albany county, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, fig. **11**; and Palæontology of New York, vol. vii, 1888, pl. 6, fig. **8.**
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, fig. **6**; and Palæontology of New York, vol. vii, 1888, pl. 6, fig. **9.**
Schoharie grit. Near Clarksville, N. Y.
Collected by R. P. Whitfield and C. Van Deloo, 1861.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, fig. **7**; and Palæontology of New York, vol. vii, 1888, pl. 6, fig. **10.**
Schoharie grit. Albany county, N. Y.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, figs. **12, 13**; and Palæontology of New York, vol. vii, 1888, pl. 6, figs. **12, 13.**
Schoharie grit. Schoharie, N. Y.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, fig. **19**; and Palæontology of New York, vol. vii, 1888, pl. 6, fig. **26**.
Schoharie grit. Schoharie, N. Y.
Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, fig. **16**; and Palæontology of New York, vol. vii, 1888, pl. 6, fig. **27**.
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, fig. **18**; and Palæontology of New York, vol. vii, 1888, pl. 6, fig. **28**.
Corniferous limestone. Near Clarence, N. Y.
Collected by R. P. Whitfield and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, fig. **17**; and Palæontology of New York, vol. vii, 1888, pl. 6, fig. **29**.
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1861.

(*) Palæontology of New York, vol. vii, 1888, pl. 8a, figs. 1, 2.
Schoharie grit. Albany county, N. Y.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 3.
Schoharie grit. Knox, N. Y.
Collected by C. Van Deloo, 1862.

Palæontolgy of New York, vol. vii, 1888, pl. 8a, fig. 4.
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1862.

Phacops cristata var. *pipa*, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 18, pl. 8a, fig. **5**.
Corniferous limestone. LeRoy, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, 1888, pl. 8a, fig. **9**.
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

(*) Palæontology of New York, vol. vii, plate 8a, fig. **10**.
Corniferous limestone. North Cayuga, Ontario.

Palæontology of New York, vol. vii, pl. 8a, figs. **11, 12.**
Corniferous limestone. Walpole, Ontario.
Collected by C. D. Walcott, 1878.

Palæontology of New York, vol. vii, pl. 8a, fig. **14.**
Corniferous limestone. Lime Rock, near LeRoy, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, vol. vii, pl. 8a, fig. **15.**
Corniferous limestone. Canandaigua, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, vol. vii, pl. 8a, fig. **17.**
Oriskany sandstone. Cayuga, Ontario.
Collected by C. D. Walcott, 1878.

Palæontology of New York, vol. vii, pl. 8a, fig. **18.**
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 31.
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, figs. 25, 26.
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Phacops bufo, Green. 1832.

(*) Monograph of the Trilobites of North America, p. 41, Cast No. **10.**
Illustration of Devonian Fossils, 1875; Crustacea, pl. 8, figs. **24, 25**; and Palæontology of New York, vol. vii, 1888, pl. 8, figs. **25, 26.**
Hamilton group. New Jersey.
The Albany Institute donor.

Phacops rana, Green. 1832.

Monograph of the Trilobites of North America, 1832, p. 42; originals of Casts Nos. **11** and **12.**
Hamilton group. Seneca, Ontario county, N. Y.
The Albany Institute donor.

(*) (*Calymene macrophthalma* (Brongniart), Green=*C. bufo*, Green.)

Monograph of the Trilobites of North America, 1832, pp. 39, 41, Cast No. 9.

Hamilton group. Locality?

The Albany Institute donor.

Illustrations Devonian Fossils, 1876; Crustacea, pl. 7, fig. 1; and Palæontology of New York, vol. vii, 1888, pl. 7, fig. 1.

Hamilton group. Geneseo, N. Y.

Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 7, fig. 5; and Palæontology of New York, vol. vii, 1888, pl. 7, fig. 5.

Hamilton group. Darien, N. Y.

Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 7, fig. 9; and Palæontology of New York, vol. vii, 1888, pl. 7, fig. 6.

Hamilton group. Geneseo, N. Y.

Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 7, figs. 6, 7; and Palæontology of New York, vol. vii, 1888, pl. 7, figs. 7, 8.

Hamilton group. Canandaigua Lake, N. Y.

Collected by R. P. Whitfield and C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 7, fig. 8; and Palæontology of New York, vol. vii, 1888, pl. 7, fig. 9.

Hamilton group. Canandaigua Lake, N. Y.

Collected by R. P. Whitfield and C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 7, figs. 10, 11 and Palæontology of New York, vol. vii, 1888, pl. 7, figs. 10, 11.

Hamilton group. Canandaigua Lake.

Collected by R. P. Whitfield and C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 8, fig. 10; and Palæontology of New York, vol. vii, 1888, pl. 8, fig. 11.

Hamilton group. Darien, N. Y.

Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 8, fig. 12; and Palæontology of New York, vol. vii, 1888, pl. 8, fig. 13.
Hamilton group. Geneseo, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 8, fig. 14; and Palæontology of New York, vol. vii, 1888, pl. 8, fig. 15.
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 8, figs. 15, 16; and Palæontology of New York, vol. vii, 1888, pl. 8, figs. 16, 17.
Hamilton group. Canandaigua Lake, N. Y.
Collected by R. P. Whitfield and C. Van Deloo, 1858.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 21.
Hamilton group. Eighteen-mile Creek, N. Y.
F. A. Randall purchase.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 22.
Hamilton group. Darien, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 28.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 29.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 30.
Hamilton group. Fultonham, N. Y.
Collected by W. M. Gabb, 1857.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 31.
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 32.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 33.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 8.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii. 1888, pl. 21, fig. 9.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 10.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 15.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 17.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 19.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 20.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 21.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 30.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Phacops anceps, Clarke. 1890.

As Trilobitas do Grez de Ereré e Maecurú, Estado do Pará, Brazil, p. 16, pl. 1, fig. 3.
Corniferous limestone. Cayuga, Ontario.
Collected by C. D. Walcott, 1878.

Genus **ODONTOCHILE**, Corda. 1847.

Dalmanites vigilans, Hall. 1861.

Rept. Progress. Geol. Surv, Wisconsin, p. 57.

Eleventh Annual Report of the Department of Geology and Natural History (Indiana), 1882, pl. 83, fig. 9.

Niagara group. Waldron, Indiana.

Collected by C. D. Walcott and C. Van Deloo, 1878.

Dalmanites limulurus, Green. 1832.

(*Asaphus Wetherilli*, Green.)

Monograph of the Trilobites of North America, p. 57; original of Cast No. 20.

Niagara limestone. Rochester, N. Y.

The Albany Institute donor.

(*Asaphus pleuroptyx*, Green.)

Monograph of the Trilobites of North America, p. 56; not figured.

Niagara limestone. Genesee River, N. Y.

The Albany Institute donor.

Dalmanites pleuroptyx, Green (sp.) 1832.

Monograph of the Trilobites of North America, p. 55; original of cast No. 18.

Lower Helderberg group. Schoharie, N. Y.

The Albany Institute donor.

Palæontology of New York, vol. iii, 1859; pl. 74, fig. 6.

Lower Helderberg group (Shaly limestone). Schoharie, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 74, fig. 7.

Lower Helderberg group (Shaly limestone). Schoharie, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 11a, fig. 1.

Lower Helderberg group (Shaly limestone). Near Clarksville, N. Y.

J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1883, pl. 11a, fig. 3.

Corniferous limestone. Lime Rock, near LeRoy, N. Y.

Ward and Howell purchase.

Dalmanites micrurus, Green (sp.). 1832.

Monograph of the Trilobites of North America, p. 56, fig. **3**; original of Cast No. **19**.

Lower Helderberg group. The Helderberg, N. Y.

The Albany Institute donor.

Palæontology of New York, vol. iii, pl. 74, figs. 1, 2. (*Dalmania pleuroptyx.*)

Lower Helderberg group (Shaly limestone). Schoharie, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. iii, text, p. 359, woodcut.

Lower Helderberg group (Shaly limestone). Schoharie, N. Y.

J. Gebhard purchase.

Dalmanites glabratus, Green. 1832.

(*) Monograph of the Trilobites of North America, p. 52, Cast No. **17**.

Horizon uncertain. Locality said to be Ripley, Ohio.

The Albang Institute donor.

Dalmanites Meeki, Walcott. 1884.

Pal. Eureka Dist., p. 207, pl. 17, figs. 5, a, b.

(*) Palæontology of New York, vol. vii, pl. 11a, fig. **28**.

Lower Devonian. Eureka District, Nevada.

(*) Palæontology of New York, vol. vii, pl. 11a, figs. **29, 30**.

Lower Devonian. Eureka District, Nevada.

Dalmanites concinnus, Hall. 1876.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 10, fig. **3**; and Palæontology of New York, vol. vii, 1888, pl. 11a, fig. **9**.

Schoharie grit. Schoharie, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 10, figs. **4, 5**; Palæontology of New York, vol. vii, pl. 11a, figs. **10, 11**.

Schoharie grit. Schoharie,N. Y.

J. Gebhard purchase.

Dalmanites phacoptyx, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 31, pl. 11a, figs. **23, 24**.

Upper Helderberg group. North Cayuga, Ontario.

Collected by J. De Cew, 1866.

Palæontology of New York, vol. vii, pl. 11a, fig. 26.
Upper Helderberg group. North Cayuga, Ontario.
Collected by J. De Cew, 1866.

Dalmanites anchiops, Green (sp.). 1832.

Monog. Tril. North Amer. p. 35.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 9, figs. 3, 4, and Palæontology of New York, vol. vii, 1888, pl. 9, figs. 2, 3.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 9, figs. 5, 6, 9; and Palæontology of New York, vol. vii, 1888, pl. 9, figs. 4, 5, 6; pl. 10, fig. 4.
Schoharie grit. Schoharie county, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 9, fig. 10; and Palæontology of New York, vol. vii, 1888, pl. 9, fig. 12.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 10, fig. 8; and Palæontology of New York, vol. vii, 1888, pl. 10, fig. 5.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 10, figs. 10, 11; and Palæontology of New York, vol. vii, 1888, pl. 10, figs. 8, 9.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 10, fig. 10.
Schoharie grit. Knox, N. Y.
Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 10, fig. 13, and Palæontology of New York, vol. vii, 1888, pl. 10, fig. 12.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils. 1876; Crustacea, pl. 10, fig. 14; and Palæontology of New York, vol. vii, 1888, pl. 10, fig. 13.

Schoharie grit. Schoharie, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 9, fig. **12**; Palæontology of New York, vol. vii, 1888, pl. 9, fig. **13**.

Schoharie grit. Ulster county, N. Y.

Dalmanites anchiops, var. *armatus*, Hall. 1861.

Fifteenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 56.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 9, fig. **12**; and Palæontology of New York, vol. ii, 1888, pl. 9, fig. **7**.

Schoharie grit. Schoharie, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 9, fig. **7**; and Palæontology of New York, vol. vii, 1888, pl. 9, fig. **8**.

Schoharie grit. Near Clarksville, N. Y.

Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils 1876; Crustacea, pl. 9, fig. **8**; and Palæontology of New York, vol. vii, 1888, pl. 9, fig. **9**.

Schoharie grit. Schoharie, N. Y.

J. Gebhard purchase.

Dalmanites anchiops, var. *sobrinus*, Hall. 1888.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 9, fig. **11**; and Palæontology of New York, vol. vii, 1888, p. 62, pl. 9, fig. **11**.

Schoharie grit. Schoharie, N. Y.

Collected by C. Van Deloo, 1862.

Dalmanites macrops, Hall. 1861.

Descr. New Species Fossils, etc., p. 59.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 13, figs. **9, 10**; and Palæontology of New York, vol. vii, 1888, pl. 11a, figs. **14, 15**.

Corniferous limestone. Schoharie, N. Y.

J. Gebhard purchase.

Dalmanites erina, Hall. 1861.

Descr. New Species Fossils, etc., p. 62.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 13, figs. **3, 4**; and Palæontology of New York, vol. vii, 1888, pl. 11a, figs. **16, 17**.
Corniferous limestone. Clarence, N. Y.

Palæontology of New York, vol. vii, 1888, pl. 11a, fig. 18.
Corniferous limestone. Boulder in town of Naples, N. Y.
J. M. Clarke purchase.

Dalmanites Calypso, Hall. 1861.

Descr. New Species Fossils, etc., p. 61.

(*) Palæontology of New York, vol. vii, 1888, pl. 11a, figs. 19, 20.
Corniferous limestone. Sandusky, Ohio.

Genus **PROBOLIUM**, Œhlert. 1890.

Dalmanites tridens, Hall. 1859.

Palæontology of New York, vol. iii, 1859, p. 361, pl. 75, fig. **3**.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 75, fig. **4**.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 75, fig. **5**.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 75, fig. **6**.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard, purchase.

Dalmanites nasutus, Conrad (sp.). 1841.

Ann. Rept. Pal. Dept. N. Y., p. 48.

Palæontology of New York, vol. iii, 1859, pl. 75, fig. 2.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard, purchase.

Palæontology of New York, vol. iii, 1859, pl. 76, fig. 1.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard, purchase.

Palæontology of New York, vol. iii, 1859, pl. 76, fig. 2.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard, purchase.

Palæontology of New York, vol. iii, 1859, pl. 76, fig. 3.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard, purchase.

Palæontology of New York, vol. iii, 1859, pl. 76, figs. 4, 5, 6.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard, purchase.

Palæontology of New York, vol. iii, 1859, pl. 76, figs. 7, 8.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Genus **ODONTOCEPHALUS**. Conrad. 1840.

Dalmanites selenurus, Eaton (sp.). 1832.

Geol. Text-book, p, 31, pl. 1, fig. 1.

Palæontology of New York, vol. vii, 1888, pl. 11b, fig. 15.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 11b, figs. 16, 17.
Corniferous limestone. Canandaigua, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, vol. ii, 1888, pl. 11b, fig. 18.
Corniferous limestone. Phelps, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, vol. vii, 1888, pl. 11b. fig. 19.
Corniferous limestone. Canandaigua, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, vol. vii, 1888, pl. 11b, fig. 21.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 12, figs. 5, 6.
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 12, fig. 7.
Corniferous limestone. Canandaigua, N. Y.
Collected by J. M. Clarke, 1885.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 12, figs. 12, 13; and Palæontology of New York, vol. vii, 1888, pl. 12, figs. 8, 9.
Corniferous limessone. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 12, figs. 1, 2; and Palæontology of New York, vol. vii, 1888, pl. 12, figs. 10, 11.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 12, fig. 12.
Corniferous limestone. Lime Rock, near Le Roy, N. Y.
Collected by J. M. Clarke, 1885.

Dalmanites Ægeria, Hall. 1861.

Descr. New Species Fossils, etc., p. 57.

Palæontology of New York, vol. vii, 1888, pl. 11b, fig. 5.
Corniferous limestone. Williamsville, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York. vol. vii, 1888, pl. 11b, fig. 10.
Corniferous limestone. Clarence, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, vol. vii, 1888, pl. 11b, fig. 11.
Corniferous limestone. Clarence, N. Y.
Collected by J. M. Clarke, 1885.

Dalmanites bifidus, Hall. 1861.

Descr. New Species Fossils, p. 63.

Palæontology of New York, vol. vii, 1888, pl. 11b, figs. 2, 3.
Corniferous limestone. Lime Rock, near Le Roy, N. Y.
Collected by J. M. Clarke, 1886.

Palæontology of New York, vol. vii, 1888, plate 11b, figs. **24**, **25**.
Corniferous limestone. Lime Rock, near Le Roy, N. Y.
Collected by J. M. Clarke, 1886.

Genus **CORYCEPHALUS**, Hall. 1888.

Dalmanites pygmæus, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p, 56, pl. 11, figs. **5**, **6**.
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 11, figs. **7**, **8**.
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Dalmanites dentatus, Barrett. 1876.

Amer. Journ. Science, vol. ii, 3d ser., p. 200.

Palæontology of New York, vol. vii, 1888, pl. 11a, fig. 5.
Lower Helderberg group. Port Jervis, N. Y.
Collected by J. W. Hall, 1877.

Palæontology of New York, vol. vii. 1888, pl. 11a, fig. 6.
Lower Helderberg group. Port Jervis, N. Y.
Collected by J. W. Hall, 1877.

Genus **CRYPHÆUS**, Green. 1837.

Dalmanites Boothi, Green (sp.). 1837.

Amer. Journ. Science, vol. 32, p. 343.

(? *Calymene microps*, Green. 1832.)

(*) Monograph of the Trilobites of North America, page 34, Cast No. **6**.
Said to be from a black limestone at Ripley, Ohio.
The Albany Institute donor.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, figs. 1, 2; and Palæontology of New York, vol. vii, 1888, pl. 16, figs. 1, 2, pl. 16a, fig. 8.
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig. 5; and Palæontology of New York, pl. 16, fig. 3.
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig. 6; and Palæontology of New York, vol. vii, 1888, pl. 16, fig. 4.

Hamilton group. Canandaigua Lake, N. Y.

Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig. 14; and Palæontology of New York, vol. vii, 1888, pl. 16a, fig. 4.

Hamilton group. Canandaigua Lake, N. Y.

Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig. 11; and Palæontology of New York, vol. vii, 1888, pl. 16a, fig. 5.

Hamilton group. Geneseo, N. Y.

Collected by C. A. White and C. Van Delo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig. 10; and Palæontology of New York, vol. vii, 1888, pl. 16a, fig. 6.

Hamilton group. Geneseo, N. Y.

Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig 12; and Paleontology of New York, vol. vii, 1888, pl. 16a, fig. 7.

Hamilton group. Canandaigua Lake, N. Y.

Collected by C. A. White and C. Van Deloo, 1860.

Dalmanites Boothi, var. *calliteles*, Green, (sp.). 1837.

Amer. Journ. Science, vol. xxxii, p. 346.

Palæontology of New York, vol. vii, 1888, pl. 16, fig. 5; 16a, fig. 12.

Hamilton group. Canandaigua, N. Y.

J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16, fig. 6; pl. 16a, fig. 13.

Hamilton group. Canandaigua, N. Y.

J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16, fig. 7; pl. 16a, fig. 14.

Hamilton group. Canandaigua, N. Y.

J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16, fig. 8.

Hamilton group. Canandaigua, N. Y.

J. M. Clarke purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, figs. 3, 4; and Palæontology of New York, pl. 16, figs. 9, 14, 15.
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Palæontology of New York, vol. vii, 1888, pl. 16, fig. 10.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16, figs. 11, 12.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16, fig. 13.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig. 7; and Palæontology of New York, vol. vii, 1888, pl. 16, fig. 16.
Hamilton group. Canandaigua, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig. 8; and Palæontology of New York, vol. vii, 1888, pl. 16, fig. 17.
Hamilton group. Canandaigua, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Palæontology of New York, vol. vii, 1888, pl. 16, figs. 19, 20, 21.
Hamilton group. Canandaigua, N. Y,
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16, fig. 22.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, pl. 16a, fig. 10.
Tully limestone. Goodwin's, Cayuga Lake, N. Y.
Donated by S. G. Williams.

Palæontology of New York, vol. vii, 1888, pl. 16a, fig. 15.
Hamilton group. Hopewell, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16a, fig. 16.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 22.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Dalmanites comis, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 41, pl. 16a, fig. 1.
Upper Helderberg group. Cayuga, Ontario.
Collected by C. D. Walcott, 1878.

Genus CRYPHINA, Œhlert. 1890.

Dalmanites serrulus, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 30, pl. 11a, fig. 12.
Corniferous limestone. North Cayuga, Ontario.

Genus CORONURA, Hall, 1888.

Dalmanites emarginatus, Hall. 1876.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 10, fig. 2; and Palæontology of New York, vol. vii, 1888, pl. 11a, fig. 7.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 11a, fig. 8.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Dalmanites aspectans, Conrad (sp.). 1841.

(=*Asaphus diurus*, Green. 1839.)

Fifth Ann. Rept. Pal. N. Y., p. 49, fig. 9.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 12, figs. 6, 8; and Palæontology of New York, vol. vii, 1888, pl. 13, figs. 3, 4.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 12, fig. 11; and Palæontology of New York, vol. vii, 1888, pl. 13, fig. 5.
Corniferous limestone. Columbus, Ohio.
Collected by R. P. Whitfield, 1865.

Palæontology of New York, vol. vii, pl. 13, fig. 9.
Corniferous limestone. Lime Rock, N. Y.
Collected by J. M. Clarke, 1885.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 10, fig. 1; and Palæontology of New York, vol. vii, pl. 13, fig. 13.
Corniferous limestone. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1865.

Dalmanites myrmecophorus, Green. 1835.

Suppl. Monogr. Tril. North Amer., p. 16.

Palæontology of New York, vol. vii, 1888, pl. 13, fig. 12.
Corniferous limestone. Lime Rock, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, vol. vii, 1888, pl. 14, fig. 1.
Corniferous limestone. Kingston, N. Y.
Tubbs purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 13, fig. 15; and Palæontology of New York, vol. vii, 1888, pl. 14, fig. 2.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 13, fig. 16; and Palæontology of New York, vol. vii, 1888, pl. 14, fig. 3.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 14, figs. 4, 5, 6.
(The originals of Conrad's *Asaphus ? acantholeurus.*)
Corniferous limestone. "Near Schoharie in limestone with Odontocephalus (Onondaga limestone)."

Palæontology of New York, vol. vii, 1888, pl. 15, figs. 1, 2, 3.
Corniferous limestone. Near Clarksville, N. Y.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 15, fig. 14.
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Dalmanites coronatus, Hall, 1861.

Descr. New Species Fossils, etc. p. 58.

Palæontology of New York, vol. vii, 1888, pl. 11b, fig. 14.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Family CERAURIDÆ.

Genus CERAURUS, Green. 1832.

Ceraurus pleurexanthemus, Green. 1832.

Monograph of the Trilobites of North America, p. 84, pl. 1, fig. 10; original of cast No. 33.
Trenton limestone. Newport, N. Y.
The Albany Institute donor.

Ceraurus? sp. indet, Hall. 1847.

Palæontology of New York, vol. i, p. 25, pl. iv bis, fig. 20.
Chazy limestone. Chazy, N. Y.
Geological Survey collection.

Family ACIDASPIDÆ.

Genus CERATOCEPHALA, Warder. 1838.

Acidaspis sp. Hall. 1888.

Palæontology of New York, vol. vii, 1888, pl. 16b, fig. 14.
Corniferous limestone. Cayuga, Ontario.

Sub-genus ACIDASPIS, Murchison. 1839.

Acidaspis tuberculata, Conrad (sp.) 1840.

Ann. Rept. Pal. Dept., N. Y., p. 205.

Palæontology of New York, vol. iii, 1859, pl. 79, figs. 1, 1a.
Lower Helderberg group. Near Clarksville, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 79, figs. 3, 5.
Lower Helderberg group. Schoharie county, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 79, fig. 8a.
Lower Helderberg group. Schoharie county, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 79, fig. 12.
Lower Helderberg group. Schoharie county, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1959, pl. 79, fig. 13.
Lower Helderberg group. Schoharie county, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 79, fig. 14.
Lower Helderberg group. Near Clarksville, N. Y.
J. Gebhard purchase.

Acidaspis Trentonensis, Hall. 1847.

("Acidaspis crosotus Locke." J. Gebhard.)

Ninth Annual Report New York State Cabinet of Natural History, pp. 45–47. 1856. Not figured.
Trenton limestone, Cape Vincent, N. Y.
Moses Eames donor.

Sub-genus **ODONTOPLEURA**, Murchison. 1839.

Acidaspis callicera, Hall. 1888.

*Palæontology of New York, vol. vii, 1888, p. 69, pl. 16b, figs. **1, 2.**
Corniferous limestone. Camillus, N. Y.

Palæontology of New York, vol. vii, 1888, pl. 16b, figs. **3, 4, 5, 6, 7**.
Corniferous limestone. Cayuga, Ontario.
Collected by C. D. Walcott, 1878.

Palæontology of New York, vol. vii, 1888, pl. 16b, fig. **9**.
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16b, fig. **13**.
Schoharie grit. Near Clarksville, N. Y.
J. M. Clarke purchase.

Sub-genus **DICRANURUS**, Conrad. 1841.

Acidaspis hamatus, Conrad (sp.). 1841.

Ann. Rep. Pal. Dept. N. Y., p. 48.

Palæontology of New York, vol. iii, pl. 79, fig. 16.
Lower Helderberg group. Schoharie county, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 79, fig. 17.
Lower Helderberg group. Schoharie county, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 79, fig. 19.
Lower Helderberg group. Albany county, N. Y.

Palæontology of New York, vol. iii, 1859, pl. 79, fig. 19a.
Lower Helderberg group. Schoharie county, N. Y.
J. Gebhard purchase.

Sub-genus ANCYROPYGE, Clarke, 1891.

Acidaspis Romingeri, Hall. 1888.

*Palæontology of New York, vol. vii, 1888, p. 71, pl. 16b, figs. **15, 16, 17, 18.**
Hamilton group. Little Traverse Bay, Michigan.

Family LICHADÆ.

Genus LICHAS, Dalman. 1826.

Sub-genus CONOLICHAS, Dames. 1877.

Lichas pustulosus, Hall. 1859.

Palæontology of New York, vol. iii, 1859, p. 366, pl. 77, figs. **9, 10.**
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 77, fig. **11**.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebbard purchase.

Palæontology of New York, vol. iii, 1859, pl. 78, fig. **2**.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 78, fig. **3**.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 78, fig. **4** (mutilated by having the terminal lobe artifically divided).
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 78, fig. **6**.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

* Palæontology of New York, vol. vii, 1888, pl. 19, fig. 8.
Lower Helderberg group (Shaly limestone). Near Clarksville, N. Y.

Palæontology of New York, vol. vii, 1888, pl. 19, fig. 10.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19, fig. 11.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Conolichas? sp., Hall. 1888.

Palæontology of New York, vol. iii, pl. 78, fig. **7** (*Lichas pustulosus*, Hall); and Palæontology of New York, vol. vii, pl. 19, fig. **9**.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

(?) *Lichas Bigsbyi*, Hall. 1859.

Palæontology of New York, vol. iii, p. 364.

* Palæontology of New York, vol. vii, 1888, pl. 19a, fig. 1.
Lower Helderberg group. Schoharie, N. Y.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 19, fig. 12.
Lower Helderberg group. Schoharie, N. Y.
J. Gebhard purchase.

(?) *Lichas Eriopis*, Hall. 1863.

Sixteenth Rept. N. Y. State Cab. Nat. Hist., p. 226.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 19, figs. **4, 5, 6, 7**; and Palæontology of New York, vol. vii, 1888, pl. 19a, figs. **2, 3, 4, 5**.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19a, fig. 7.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 19a, fig. 8.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 19, fig. **10**; and Palæontology of New York, vol. vii, 1888, pl. 19a, fig. **9**.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 19, fig. 12 [*Acidaspis* (*Terataspis*) *sp.*]; and Palæontology of New York, vol. vii, 1888, pl. 19a, fig. 11.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19a, figs. 13, 15, 16.
Corniferous limestone (drift). Canandaigua, N. Y.
Collected by J. M. Clarke, 1885.

? *Lichas hispidus*, Hall. 1888.

Palæontology of New York, vol. vii, p. 77.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 19, figs. **8, 9**; and Palæontology of New York, vol. vii, 1888, pl. 19a, figs. **14, 17**.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19a, fig. **18**.
Corniferous limestone. Le Roy, N. Y.
Collected by C. D. Walcott and C. Van Deloo, 1877.

Sub-genus CERATOLICHAS, Hall. 1888.

Lichas gryps, Hall. 1888.

Palæontology of New York, vol. vii, p. 84.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 19, fig. **1**; and Palæontology of New York, vol. vii, 1888, pl. 19b, figs. **7, 8**.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19b, figs. **9, 10, 11**.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 19b, figs. **12, 12a, 13.**
Corniferous limestone. Canandaigua, N. Y.
Collected by J. M. Clarke, 1886.

Lichas dracon, Hall. 1888.

Palæontology of New York, vol. vii, pl. 85.

Illustrations of Devonian Fossils, pl. 19, figs. **2, 3;** and Palæontology of New York, vol. vii, 1888, pl. 19b, figs. **14, 15.**
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, pl. 19b, figs. **16, 17.**
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19b, figs. **18, 18a.**
Corniferous, limestone. Le Roy, N. Y.
Collected by J. M. Clarke, 1886.

Sub-genus ARGES, Goldfuss. 1839.

Lichas contusus, Hall. 1888.

Palæontology of New York, vol. viii, 1888, p. 83, pl. 19b, fig. **3.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 19b, figs. **4, 5, 6.**
Corniferous limestone. Near Clarksville, N. Y.
Collected by J. W. Hall, 1877.

Sub-genus TERATASPIS, Hall. 1863.

Lichas grandis, Hall. 1861.

Descr. New Species Foss., p. 82.

Illustrations of Devonian Fossils, 1876: Crustacea, pl. 17, figs. **1, 2;** and Palæontology of New York, vol. vii. 1888, pl. 17, figs. **2, 3.**
Schoharie grit. Knox, N. Y.
Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 17, figs. **5, 4;** and Palæontology of New York, vol. vii, pl. 17, figs. **4, 5.**
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19, fig. 1.
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1862.

Palæontology of New York, vol. vii, 1888, pl. 19, fig. 2.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 18, fig. **4**; and Palæontology of New York, vol. vii, 1888, pl. 19, fig. **5.**
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19, fig. 6.
Schoharie grit. Knox, N. Y.
Collected by C. Van Deloo, 1862.

Palæontology of New York, vol. vii, 1888, pl. 19, fig. 7.
Schoharie grit. Thompson's Lake, N. Y.
Collected by C. Van Deloo, 1862.

Sub-genus DICRANOGMUS, Corda. 1847.

Lichas ptyonurus, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 86, pl. 19b, fig. **19.**
Niagara group (Coralline limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19b, fig. **20.**
Niagara group (Coralline limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19b, fig. **21.**
Niagara group (Coralline limestone). Schoharie, N. Y.
J. Gebhard purchase.

Family PROETIDÆ.

Genus PROETUS, Steininger. 1831.

Proetus Corycœus, Conrad (sp.) 1842.

Journ. Acad. Nat. Sci., vol. 8, p. 277.

Palæontology of New York, vol. ii, pl. 67, fig. 15.
Niagara group. Lockport, N. Y.

Proetus protuberans, Hall. 1859.

Palæontology of New York, vol. iii, 1859, p. 351, pl. 73, fig. 5.
Lower Helderberg group. Schoharie, N. Y.
J. Gebhard purchase.

Proetus angustifrons, Hall. 1861.

Descr. New Species Fossils, p. 70.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 1.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 2.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 3.
Schoharie grit. Near Clarksville, N. Y.
J. M. Clarke purchase.

Proetus Conradi, Hall. 1861.

Descr. New Species Fossils, p. 69.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 4.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Proetus Hesione, Hall. 1861.

Descr. New Species Fossils, p. 70.

*Illustrations of Devonian Fossils, 1876; Crustacea, pl. 20, figs. 15, 16; and Palæontology of New York, vol. vii, 1888, pl. 20, figs. 15, 16.
Schoharie grit. Schoharie, N. Y.

Proetus sp., Hall, 1888.

Palæontology of New York, vol. vii, 1888, p. 94, pl. 22, fig. 5.
Schoharie grit, Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 6.
Schoharie grit. Knox, N. Y.
Collected by C. Van Deloo, 1862,

Proetus curvimarginatus, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 94, pl. 22, fig. **13**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, figs. **14, 15**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, pl. 22, fig. **16**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. **17**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, figs. **18, 19**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Proetus latimarginatus, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 97, pl. 22, fig. **7**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. **8**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. **9**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. **10**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. **11**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. **12**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Proetus clarus, Hall. 1861.

Descr. New Species Fossils, p. 71.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 28.
Corniferous limestone. Decewville, Ontario.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 29.
Corniferous limestone. Lime Rock, near Le Roy, N. Y.
Collected by J. M. Clarke, 1888.

Proetus folliceps, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 101, pl. 23, figs. **3, 4, 8**.
Corniferous limestone. Near Le Roy, N. Y.
Collected by C. D. Walcott and C. Van Deloo, 1877.

Palæontology of New York, vol. vii, 1888, pl. 23, figs. **6, 7**.
Corniferous limestone (drift). Ann Harbor, Michigan.
Donated by C. Rominger.

Proetus delphinulus, Hall. 1888.

* Palæontology of New York, vol. vii, 1888, p. 111, pl. 23, figs. **1, 2**; pl. 25, fig. **6**.
Corniferous limestone. Port Colborne, Ontario.

Proetus canaliculatus, Hall. 1861.

Descr. New Species Fossils, p. 73.

Palæontology of New York, vol. vii, 1888, pl. 23, figs. 10, 11.
Corniferous limestone. Falls of the Ohio.

Proetus crassimarginatus, Hall. 1843.

Geol. N. Y.; Rept. Fourth Dist., p. 172, fig. 5.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 20, fig. 5; and Palæontology of New York, vol. vii, 1888, pl. 20, fig. 6.
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 20, figs. 8, 9; and Palæontology of New York, vol. vii, 1888, pl. 20, figs. 7, 8.
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 20, figs. 23, 24; and Palæontology of New York, vol. vii, 1888, pl. 20, figs. 23, 24.
Coniferous limestone. Clarence, N. Y.
Collected by C. A. White, R. P. Whitfield and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 20, fig. 27; and Palæontology of New York, vol. vii, 1888, pl. 20, fig. 27.
Corniferous limestone. Cayuga, Ontario.
Collected by J. De Cew, 1866.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 20.
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1862.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 21.
Schoharie grit. Near Clarksville, N. Y.
Collected by C Van Deloo, 1862.

Palæontology of New York, vol. vii, 1888, pl. 22. fig. 23.
Corniferous limestone. Falls of the Ohio.

Proetus ? planimarginatus, Meek. 1871.

Proc. Acad. Nat. Sci. Phil., p. 89.

* Palæontology of New York, vol. vii, 1888, pl. 23, fig. 21.
Corniferous limestone. Sylvania, Ohio.

Proetus stenopyge, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 110, pl. 22, fig. 27.
Corniferous limestone. Phelps, N. Y.
Collected by J. M. Clarke, 1886.

Proetus ovifrons, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 110, pl. 22, fig. 31.
Corniferous limestone (drift). Canandaigua, N. Y.
Collected by J. M. Clarke, 1886.

Palæontology of New York, vol. vii, 1888, p. 22, fig. 32.
Corniferous limestone (drift). Canandaigua, N. Y.
Collected by J. M. Clarke, 1886.

Proetus microgemma, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 109, pl. 22, fig. 33.
Corniferous limestone. Phelps, N. Y.
Collected by J. M. Clarke, 1886.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. **34**.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Proetus Rowi, Green (sp.). 1838.

Amer. Journ. Sci., vol. 33, p. 406.

* Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. 4; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. 4.
Hamilton group. Otsego county, N. Y.

* Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. 5; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. 5.
Hamilton group. Otsego county, N. Y.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. 24; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. 24.
Tully limestone. Near Ovid, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 23, fig. 20.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 23, fig. 22.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 23, fig. 23.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 23, fig. 24.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

* Palæontology of New York, vol. vii, 1888, pl. 23, fig. 25.
Hamilton group (drift). Ann Arbor, Michigan.

Palæontology of New York, vol. vii, 1888, pl. 23, fig. 26.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, figs. 25, 26; and Palæontology of New York, vol. vii, 1888, pl. 21, figs. 25, 26; pl. 23, fig. 27.

Tully linestone. Near Ovid, N. Y.

J. Gebhard purchase.

(*) Palæontology of New York, vol. vii. 1888, pl. 23, fig. 29.

Hamilton group. Centerfield, N. Y.

J. M. Clarke purchase.

Proetus Haldemani, Hall. 1861.

Descr. New Species Fossils, p. 74.

* Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, figs. **7**, **8**; and Palæontology of New York, vol. vii, 1888, pl. 21, figs. **7**, **8**; pl. 23, fig. **15**.

Hamilton group. Pennsylvania.

* Palæontology of New York, vol. vii, 1888, pl. 23, fig. 13.

Devonian. Rescue Hill, Eureka District, Nevada.

Proetus macrocephalus, Hall. 1861.

Descr. New Species Fossils, p. 77.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. **10**; Palæontology of New York, vol. vii, 1888, pl. 21, fig. **10**.

Hamilton group. Canandaigua Lake, N. Y.

Collected by R. P. Whitfield and C. Van Deloo, 1858.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. **13**; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. **13**.

Hamilton group. York, N. Y.

Collected by J. W. Hall and C. Van Deloo, 1866.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. **14**; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. **14**.

Hamilton group. Canandaigua Lake, N. Y.

Collected by R. P. Whitfield and J. W. Hall, 1858.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig **17**; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. **17**.

Hamilton group. Canandaigua Lake, N. Y.

Collected by R. P. Whitfield and J. W. Hall, 1858.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. **18**; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. **18.**
Hamilton group. Locality?

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. **19**; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. **19.**
Hamilton group. North Bristol, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Palæontology of New York, vol. vii, 1888, pl. 23, fig. 30.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 23, fig. 31.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Proetus Prouti, Shumard. 1863.

Trans. St. Louis Acad. Sci., vol. ii, No. 1, p. 110.

(*Proetus Davenportensis*, Barris, 1878, Proc. Davenport Acad. Nat. Sci., vol. ii, p. 287.)
* Palæontology of New York, vol. vii, 1888, pl. 23, figs. **16, 17.**
Hamilton group. Smith's Quarry, Davenport, Iowa.

* Palæontology of New York, vol. vii, 1888, pl. 23, fig. 18
Hamilton group. Cook's Quarry, Davenport, Iowa.

Proetus Phocion, Billings. 1874.

Pal. Foss. Canada, vol. ii, p. 63.

* Palæontology of New York, vol. vii, 1888, pl. 25, fig. **9.**
Hamilton group. Indian Cove, Gaspé, Quebec.

* Palæontology of New York, vol. vii, 1888, pl. 25, fig. **10.**
Hamilton group. Indian Cove, Gaspé, Quebec.

Proetus Nevadæ, Hall. 1888.

* Palæontology of New York, vol. vii, 1888, p. 129, pl. 23, fig. **19.**
Devonian. Comb's Peak, Eureka District, Nevada.

Proetus Missouriensis, Shumard. 1855.

Geol. Rept. Miss., p. 196.

(*Proetus auriculatus*, Hall, 1861. Descr. New Species Fossils, p. 79.)
Palæontology of New York, vol. vii, 1888, pl. 23, fig. **32.**
Waverly group. Licking county, Ohio.

Genus CORDANIA, Clarke. 1893.

Phaëthonides cyclurus, Hall. 1888.

Palæontology of New York, vol. vii, p. 137, pl. 24, figs. **26, 26a.**
Lower Helderberg group (Shaly limestone). Near Clarksville, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **27**.
Lower Helderberg group (Shaly limestone). Near Clarksville, N.Y.
J. M. Clarke purchase.

Palæntology of New York, vol. vii, 1888, pl. 24, fig. **28.**
Lower Helderberg group (Shaly limestone). Near Clarksville, N.Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 25, fig. **11.**
Lower Helderberg group (Shaly limestone). Near Clarksville, N.Y.
J. M. Clarke purchase.

Phaëthonides arenicolus, Hall. 1888.

*Palæontology of New York, vol. vii, 1888, p. 134, pl. 25, fig. **12.**
Schoharie grit. Schoharie, N. Y.

Phaëthonides varicella, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 135, pl. 24, figs. **29, 29a.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, figs. **30, 30a**.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **31**.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Phaëthonides gemmæus, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 136, pl. 24, fig. **32**.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **33.**
Hamilton group. Eighteen-mile Creek, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **34.**
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **35.**
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **36.**
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Phaëthonides Macrobius, Billings (sp.). 1863.

Proc. Portland Soc. Nat. Hist., p. 123.

Palæontology of New York, vol. vii, 1888, pl. 24, figs. 24, 24a.
Lower Helderberg group. Square Lake, Maine.
J. M. Clarke purchase.

Genus CYPHASPIS, Burmeister. 1843.

Cyphaspis cœlebs, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 151, pl. 24, fig. **1.**
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Cyphaspis minuscula, Hall (sp.). 1876.

Illustr. Devon. Fossils. Expl. pl. 20, fig. 17.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. 7.
Schoharie grit. Near Clarksville, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, figs. 8, 8a.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, figs. 9, 10.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. 11.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. 12.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Cyphaspis stephanophora, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 142, pl. 24, figs. **2, 3.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **4.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **5.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York. vol. vii, 1888, pl. 24, figs. **6, 6a.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Cyphaspis diadema, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 141, pl. 24, fig. **13.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Cyphaspis hybrida, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 144, pl. 24, fig. **14.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Cyphaspis craspedota, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 148, pl. 24, figs. **15, 16, 17.**
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, figs. **18, 19.**
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **20.**
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Cyphaspis ornata, Hall. 1876.

Illustr. Dev. Foss. Exp., pl. 21, fig. 1.

Palæontology of New York, vol. vii, 1888, pl. 24, figs. 21, 21a.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Cyphaspis ornata, var. baccata, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 146, pl. 24, figs. **22, 22a.**
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **23.**
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

MEROSTOMATA.

Family EURYPTERIDÆ.

Genus EURYPTERUS, DeKay, 1825.

Eurypterus prominens, Hall. 1888.

(*) Palæontology of New York, vol. vii, 1888, p. 157, pl. 27, figs. **3, 4.**
Clinton group. Northern part of Cayuga county, N. Y.

Eurypterus remipes, DeKay. 1825.

Ann. Lyc. Nat. Hist. N. Y., p. 375.

Palæontology of New York, vol. iii, 1859, pl. 80a, fig. 11.
Waterlime formation. Waterville, N. Y.
J. Gebhard purchase.

Eurypterus lacustris, Harlan. 1834.

Trans. Geol. Soc. Penna., vol. i, p. 98.

Palæontology of New York, vol. iii, 1859, pl. 81, fig. 3.
Waterlime formation. Williamsville, N. Y.
J. Gebhard purchase.

Eurypterus pachycheirus, Hall. 1859.

Palæontology of New York, vol. iii, 1859, p. 412,* pl. 82,* figs. **1, 1a.**
Waterlime formation. Near Buffalo, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 82,* fig. **3.**
Waterlime formation. Near Buffalo, N. Y.
J. Gebhard purchase.

Eurypterus DeKayi, Hall. 1859.

Palæontology of New York, vol. iii, 1859, p. 411,* pl. 82, fig **1.**
Waterlime formation. Black Rock, N. Y.
J. Gebhard purchase.

Eurypterus Beecheri, Hall. 1884.

Second Geol. Surv. Penna. PPP., p. 30.

* Palæontology of New York, vol. vii, 1888, pl. 27, fig. **5.**
Chemung group. Warren, Pennsylvania.

Eurypterus approximatus, Hall. 1888.

(*) Palæontology of New York, vol. vii, 1888, expl. pl. 27, fig. **6.**
Waverly group. Near Warren, Pennsylvania.

Genus **STYLONURUS**, Page. 1856.

Stylonurus excelsior, Hall. 1883.

Thirty-sixth Rept. N. Y. State Mus. Nat. Hist., p. 77.

(*) Palæontology of New York, vol. ii, 1888, pl. 26, fig. **1.**
Catskill group. Andes, N. Y.

(*) Palæontology of New York, vol. vii, 1888, pl. 26a, figs. **1, 2, 3** (*Dolichocephala Lacoana*, Claypole, 1883, Proc. Amer. Philos. Soc. vol. xxi, p. 236).
Catskill group. Meshoppen, Pennsylvania.

Stylonurus? (Echinocaris?) Wrightianus, Dawson.

Quart. Journ. Geol. Soc. vol. xxxvii, p. 301.

(*) Palæontology of New York, vol. vii, 1888, pl. 27, figs. **7, 8, 9.**
Portage group. Italy, N. Y.

PHYLLOCARIDA.

Family CERATIOCARIDÆ.

Genus ECHINOCARIS, Whitfield. 1880.

Æchinocaris punctata, Hall. 1863.

Sixteenth Rept. N. Y. State Cab. Nat. Hist., p. 74.

Palæontology of New York, vol. vii, 1888, pl. 27, fig. 10; pl. 28, fig. 4.

Hamilton group. Canandaigua Lake, N. Y.

Collected by J. M. Clarke, 1886.

Palæontology of New York, vol. vii, 1888, pl. 28, figs. 1, 2; pl. 29, fig. 6.

Hamilton group. Fabius, N. Y.

Collected by G. B. Simpson, 1863.

Palæontology of New York, vol. vii, 1888, pl. 28, fig. 3.

Hamilton group. Pratt's Falls, N. Y.

Collected by H. H. Smith and C. Van Deloo, 1874.

Palæontology of New York, vol. vii, 1888, pl. 28, fig. 5.

Hamilton group. Pratt's Falls, N. Y.

Collected by H. H. Smith and C. Van Deloo, 1874.

Sixteenth Report on New York State Cabinet of Natural History, 1863, pl. 1, figs. 1, 2; Illustrations of Devonian Fossils, 1876; Crustacea, pl, 23, figs. 4, 5; and Palæontology of New York, vol. vii, 1888, pl. 28, figs. 6, 7.

Hamilton group. Canandaigua Lake, N. Y.

Collected by C. A. White and C. Van Deloo, 1860.

Palæontology of New York, vol. vii, 1888, pl. 29, figs. 1, 2.

Hamilton group. Pratt's Falls, N. Y.

Collected by H. H. Smith and C. Van Deloo, 1874.

Palæontology of New York, vol. vii, 1888, pl. 29, fig. 3.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1874.

Palæontology of New York, vol. vii, 1888, pl. 29, fig. 4.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1874.

Palæontology of New York, vol. vii, 1888, pl. 29, fig. 5.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1874.

Palæontology of New York, vol. vii, 1888, pl. 29, fig. 7.
Hamilton group. Cayuga Lake, N. Y.
Collected by H. H. Smith, 1871.

Sixteenth Report on New York State Cabinet of Natural History, 1863, pl. 1, fig. 8; Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. 7; and Palæontology of New York, vol. vii, 1888, pl. 29, fig. 8.
Hamilton group. Cayuga Lake, N. Y.
Collected by C. A. White, 1860.

Mandibles of Phyllocarida (Echinocaris punctata).

Palæontology of New York, vol. vii, 1888, pl. 30. fig. 13.
Hamilton group. Pratt's Falls. N. Y.
Collected by J. W. Hall, 1875.

Palæontology of New York, vol. vii, 1888, pl. 30, fig 14.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith, 1873.

Palæontology of New York, vol. vii, 1888, pl. 30, fig. 15.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1873.

Palæontology of New York, vol. vii. 1888, pl. 30, fig. 16.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1873.

Palæontology of New York, vol. vii, 1888, pl. 30, fig. 17.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1873.

Palæontology of New York, vol. vii. 1888, pl. 30, fig. **18.**
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1873.

Palæontology of New York, vol. vii, 1888, pl. 30, fig. **19.**
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1873.

[?] *Ceratiocaris longicauda*, Hall. 1861.

Sixteenth Report on New York State Cabinet of Natural History, 1861, p. 73, pl. 1, fig. **7** (not figs. 4, 5, 6 = *Coleolus* or *Orthoceras*); and Palæontology of New York, vol. vii, 1888, pl 31, fig. **1.**
Genesee shales. Bristol Center, N. Y.
Collected by R. P. Whitfield and C. Van Deloo, 1862.

Echinocaris Whitfieldi, Clarke. 1885.

Bull. No. 16. U. S. Geol. Surv. p. 45.

Palæontology of New York, vol. vii, 1888, pl. 29, fig. **20.**
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

* Palæontology of New York, vol. vii, 1888, pl. 29, fig. **21.**
Naples beds. Naples, N. Y.

[?] *Ceratiocaris Beecheri*, Clarke. 1885.

Palæontology of New York, vol. vii, 1888, pl. 30, fig. **3.**
Naples beds. Sonyea, N. Y.

Echinocaris condylepis, Hall. 1880.

Palæontology of New York, vol. vii, 1888, p. 173, pl. 29, figs. **14, 15.**
Chemung group. Belmont, N. Y.
Collected by Andrew Sherwood, 1871.

Palæontology of New York, vol. vii, 1888, pl. 29, figs. **16, 17.**
Chemung group. Belmont, N. Y.
Collected by Andrew Sherwood, 1871.

Echinocaris socialis, Beecher. 1884.

Second Geol. Surv. Penna., PPP, p. 10.

* Palæontology of New York, vol. vii, 1888, pl. 30, fig. **6.**
Chemung group. Warren, Pennsylvania.

Palæontology of New York, vol. vii, 1888, pl. 30, fig. 7.
Chemung group. Warren, Pennsylvania.
F. A. Randall purchase.

* Palæontology of New York, vol. vii, 1888, pl. 30, fig. **8.**
Chemung group. Warren Pennsylvania.

Palæontology of New York, vol. vii, 1888. pl. 30, fig. 10.
Chemung group. Warren, Pennsylvania.
F. A. Randall purchase.

Echinocaris multinodosa, Whitfield. 1880.

Amer. Journ. Science, vol. xix, p. 38.

* Palæontology of New York, vol. vii, 1888, pl. 29, fig. **18.**
Erie shale. Paine's Creek, Ohio.

* Palæontology of New York, vol. vii, 1888, pl. 29, fig. **19.**
Erie shale. Paine's Creek, Ohio.

Echinocaris pustulosa, Whitfield. 1880.

Amer. Journ. Science, vol. xix, p. 38.

* Palæontology of New York, vol. vii, 1888, pl. 29, figs. **9, 10.**
Erie shale. Paine's Creek, Ohio.

Echinocaris sublœvis, Whitfield. 1880.

Amer. Journ. Science, vol. xix, p. 36.

* Palæontology of New York, vol. vii, 1888, pl. 29, figs. **11, 12.**
Erie shale. Paine's Creek, Ohio.

Genus ELYMOCARIS, Beecher. 1884.

Elymocaris capsella, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 181, pl. 31, fig. **4.**
Hamilton group. Canandaigua lake, N. Y.
J. M. Clarke purchase.

Elymocaris siliqua, Beecher. 1884.

Second Geol. Surv. Penna. PPP, p. 13.

* Palæontology of New York, vol. vii, 1888, pl. 31, fig. **5.**
Chemung group. Warren, Pennsylvania.

* Palæontology of New York, vol. vii, 1888, pl. 31, fig. **6.**
Chemung group. Warren, Pennsylvania.

Genus TROPIDOCARIS, Beecher. 1884.

Tropicodaris Hamiltoniæ. Hall, 1888.

Palæontology of New York, vii, 1888, expl. pl. 30, figs. **24, 25.**
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Tropidocaris interrupta, Beecher. 1884.
Second Geol. Surv. Penna. PPP, p. 18.

* Palæontology of New York, vol. vii, 1888, pl. 31, fig. **13.**
Chemung group. Warren, Pennsylvania.

Tropidocaris bicarinata, Beecher. 1883.
Second Geol. Surv. Penna. PPP. p. 16.

* Palæontology of New York, vol. vii, 1888, pl. 31, figs. **7, 9.**
Chemung group. Warren, Pennsylvania.

Palæontology of New York, vol. vii, 1888, pl. 31, figs. 8, 10.
Chemung group. Warren, Pennsylvania.
F. A. Randall purchase.

* Palæontology of New York, vol. vii, 1888, pl. 31, fig. **11.**
Chemung group. Warren, Pennsylvania.

Tropidocaris alternata, Beecher. 1884.
Second Geol. Surv. Penna. PPP. p. 19.

* Palæontology of New York, vol. vii, 1888, pl. 31, fig. **14.**
Waverly group. Warren; Pennsylvania.

* Palæontology of New York, vol. vii, 1888, pl. 31, fig. **15.**
Waverly group. Warren, Pennsylvania.

Family RHINOCARIDÆ.

Genus RHINOCARIS, Clarke. 1888.

Rhinocaris columbina, Clarke. 1888.

Palæontology of New York, vol. vii, 1888, p. 196, pl. 31, figs. **16, 17.**
Hamilton group. Canandaigua Lake, N. Y.
Collected by J. M. Clarke, 1886.

Palæontology of New York, vol. vii, 1888, pl. 31, fig. **18.**
Hamilton group. Cayuga Lake, N. Y.
Collected by H. H. Smith, 1871.

Palæontology of New York, vol. vii, 1888, pl. 31, fig. **19.**
Hamilton group. Cayuga Lake, N. Y.
Collected by H. H. Smith, 1871.

Palæontology of New York, vol. vii, 1888, pl. 31, fig. **20.**
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Rhinocaris scaphoptera, Clarke. 1888.

Palæontology of New York, vol. vii, 1888, p. 197, pl. 31, figs. **22, 23.**
Hamilton group. Canandaigua Lake, N. Y.
Collected by J. M. Clarke, 1886.

Genus **MESOTHYRA**, Hall. 1888.

Mesothyra Veneris, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 193, pl. 33, fig. **3.**
Marcellus shale. East Bloomfield, N. Y.
J. M. Clarke purchase.

Mesothyra Neptuni, Hall. 1863.

Sixteenth Report on New York State Cabinet of Natural History, 1863, p. 75, pl. 1, fig. **9**; Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. **6**; and Palæontology of New York, vol. vii, 1888, pl. 32, fig. **7**; pl. 33, fig. **1.**
Hamilton group. Plainfield, N. Y.
J. Gebhard purchase.

Mesothyra spumæa, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 93, pl. 32, figs. **8, 9.**
Hamilton group. Delphi, N. Y.
Collected by J. W. Hall and G. B. Simpson, 1875.

Palæontology of New York, vol. vii, 1888, pl. 33, fig. **2.**
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1874.

Mesothyra Oceani, Hall. 1888.

Pal. N. Y., vol. vii, p. 187.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. **1**; Palæontology of New York, vol. vii, 1888, pl. 32, fig. **3**; pl. 33, fig. **5.**
Portage group. Ithaca, N. Y.
Collected by J. W. Hall and G. B. Simpson, 1870.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. 2; and Palæontology of New York, vol. vii, 1888, pl. 34, fig. 2.

Portage group. Ithaca, N. Y.

Collected by J. W. Hall and G. B. Simpson, 1870.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. 3; and Palæontology of New York, vol. vii, 1888, pl. 34, fig. 1.

Portage group. Ithaca, N. Y.

Collected by J. W. Hall and G. B. Simpson, 1870.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. 4; and Palæontology of New York, vol. vii, 1888, pl. 32, fig. 5; pl. 34, fig. 4.

Portage group. Ithaca, N. Y.

Collected by J. W. Hall and G. B. Simpson, 1870.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. 5; and Palæontology of New York, vol. vii, 1888, pl. 34, fig. 3.

Portage group. Ithaca, N. Y.

Collected by J. W. Hall and G. B. Simpson, 1870.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. 1; and Palæontology of New York, vol. vii, 1888, pl. 33, fig. 6.

Portage group. Ithaca, N. Y.

Collected by J. W. Hall and G. B. Simpson, 1870.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23; fig. 2; and Palæontology of New York, vol. vii, 1888, pl. 33, fig. 7.

Portage group. Ithaca, N. Y.

Collected by J. W. Hall and G. B. Simpson, 1870.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. 3; and Palæontology of New York, vol. vii, 1888, pl. 34, fig. 5.

Portage group. Ithaca, N. Y.

Collected by J. W. Hall and G. B. Simpson, 1870.

Palæontology of New York, vol. vii, 1888, pl. 32, figs. 1, 2, 4, 6; pl. 33, fig. 4.

Portage group. Ithaca, N. Y.

Collected by J. W. Hall and G. B. Simpson, 1870.

Family DISCINOCARIDÆ.

[?] Genus SPATHIOCARIS, Clarke. 1882.

Spathiocaris Emersoni, Clarke. 1882.

Amer. Journ. Science, 3d Ser., vol. 23, p. 447.

Palæontology of New York, vol. vii, 1888; pl. 35, fig. **12.**
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. 13.
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. 14.
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. **15.**
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. 16.
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. **17**.
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. 18.
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. 19.
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

(?) Genus DIPTEROCARIS, Clarke. 1883.

Dipterocaris pes-cervæ, Clarke. 1883.

Amer. Journ. Science, 3d ser., vol. 25, p. 123.

Palæontology of New York, vol. vii, 1888, pl. 35, figs, **20, 21.**
Chemung group. Dansville, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, figs. 22, 23.
Naples beds. Naples, N. Y.

J. M. Clarke purchase.

Dipterocaris pennæ-Dædali, Clarke. 1883.

Amer. Journ. Science, 3d ser., vol. xxv, p. 122.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. **24**.
Portage group. Canadice, N. Y.

J. M. Clarke purchase.

Dipterocaris Procne, Clarke. 1883.

Amer. Journ. Science, 3d ser., vol. xxv, p. 122.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. **25**.
Portage group. Canadice, N. Y.

J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, figs. **26, 27**.
Chemung group. Haskinsville, N. Y.

J. M. Clarke purchase.

PHYLLOPODA.

Family **LIMNIADIADÆ.**

Genus **ESTHERIA**, Ruppell.

Estheria pulex, Clarke. 1882.

Amer. Journ. Science, vol. 23, p. 476.

Palæontology of New York, vol. vii, 1888, pl. 35, figs. **10, 11.**
Hamilton group. Hopewell, N. Y.
J. M. Clarke purchase.

Genus **SCHIZODISCUS**, Clarke.

Schizodiscus capsa, Clarke. 1888.

Palæontology of New York, vol. vii, 1888, p. 209, pl. 35, figs. **1, 2.**
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, figs. **3, 4.**
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. **5.**
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. **6.**
Hamilton group. Centerfield, N. Y.
J. M. Clark purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, figs. **7, 8.**
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. **9.**
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

DECAPODA.

Family CARIDIDÆ.

Genus PALÆOPALÆMON, Whitfield. 1880.

Palæopalæmon Newberryi, Whitfield. 1880.

Amer. Jour. Science, vol. 19, p. 41.

*Palæontology of New York, vol. vii, 1888, pl. 30, figs. **20, 21, 22, 23.**

Erie shale. Le Roy, Ohio.

Summary.

Crustacea.

Total original specimens	248
Total illustrated specimens	496
Total casts of original specimens	50
Total figures of these specimens	742

Record of Localities of Extra Limital Geological and Palæontological Collections of the New York State Museum.

[Specimens marked with round orange-colored tickets.]

No. 157. Clinton group. Hamilton, Ontario, Canada. C. D. Walcott collector. 1878.

No. 180. Niagara shale. Waldron, Shelby county, Indiana. C. D. Walcott and C. Van Deloo, collectors. 1878.

No. 181. Niagara limestone. Charlestown, Clark county, Indiana. C. D. Walcott, collector. 1878.

No. 182. Niagara limestone. Flat Rock creek, Shelby county, Indiana. C. D. Walcott, collector. 1878.

No. 183. Niagara limestone. Hamilton, Ontario, Canada. C. D. Walcott, collector. 1878.

No. 255. Sandstone, =Schoharie grit. Pendleton, Madison county, Indiana. C. D. Walcott and C. Van Deloo, collectors. 1878.

No. 278. Corniferous limestone. Charlestown, Clarke county, Indiana. C. D. Walcott and C. Van Deloo, collectors.

No. 278a. Corniferous limestone. Lexington, Scott county, Indiana. C. D. Walcott and C. Van Deloo, collectors.

No. 279. Corniferous limestone. Falls of the Ohio. From Sidney Lyon.

No. 279a. Corniferous limestone. Falls of the Ohio. C. D. Walcott, collector. 1877.

No. 280. Corniferous limestone. South Walpole, Ontario, Canada, 4th Con. Lot 14. C. D. Walcott, collector. 1878.

No. 281. Corniferous limestone. North Walpole, Ontario, Canada. 13 Con. Lot 5. C. D. Walcott, collector. 1878.

No. 282. Corniferous limestone. South Cayuga. 4th Con. Lots 30 and 32. C. D. Walcott, collector. 1878.

No. 283. Corniferous limestone. Pt. Colborne and Wainfleet, Ontario, Canada. 1 and 2 Con. C. D. Walcott, collector. 1878.

No. 284. Corniferous limestone. Kelly's Island and on Pt. Marble Head, Ohio. C. D. Walcott, collector. 1878.

No. 300. Hamilton group. Falls of the Ohio and southern Indiana. Sidney Lyon.

No. 301. Hamilton group. Lexington, Scott county, Indiana. C. D. Walcott and C. Van Deloo, collectors. 1878.

No. 324. Hamilton group. Just beneath the Black slate (Genesee). Lexington, Scott county, Indiana. C. D. Walcott, collector.

No. 324a. Hamilton group? Beneath the Waterlime. Lexington, Scott county, Indiana. C. D. Walcott, collector.

No. 326. New Albany Black slate=(Genesee slate of New York). Lexington, Scott county, Indiana. C. D. Walcott and C. Van Deloo, collectors.

No. 350. Carboniferous limestone. Crawfordsville, Indiana. C. D. Walcott, collector. 1877.

On Cordania, a Proposed New Genus of Trilobites.

By **John M. Clarke.**

In the Palæontology of New York, volume vii, 1888, certain cephala and pygidia of trilobites from the Upper and Lower Helderberg and Hamilton groups of various localities in the State of New York and elsewhere were tentatively referred to the genus PHAETHONIDES as defined by Angelin. A careful restudy of these fossils and review of the literature pertaining to them, educes the fact that Angelin included under his redefinition of this term PHAETHONIDES, forms which Barrande, the author of the name, never intended to bring into so close association, and which can not be properly regarded as congeneric.

The name PHAETON was introduced by Barrande in 1846* for a genus of trilobites, built on the general plan of PROETUS, but having a dentate pygidium. The type of the group was *Phaeton Archiaci*, from the etage E. This name, however, had been used by Brisson in 1770 for a genus of birds. In 1847, Corda† observed this fact of synonymy and substituted for Barrande's term, the name PRIONOPELTIS. He defined the groups clearly and at length, describing all the parts of the animals, and subdivided his twelve species into two principal groups: A, those with simple, uncarinate cephalic margin; B, those with this margin carinate; and of these groups the first was divided into those (a) with 8 lateral pygidial spines, (b) with 7, (c) with 6 or 5 such spines. An excellent illustration was given of the species *P. Polydorus*, a member of the second division of the first group, though the first species of his typical group is his *P. Priamus.* In the first volume of the "Systeme silurien du Centre de la Boheme," in 1852, Barrande did not formally withdraw his term PHAETON, nor acknowledge its preoccupation. He there retains the term in a subgeneric sense, using it as equivalent to his "Groupe B" of the Proeti, viz.; that having the margin of the pygidium ornamented with spines.

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* Notice préliminaire sur le systéme silurien et les Trilobités de Bohême, p. 62.

† Prodrom einer Monographie der Böhmischer Trilobiten, p. 122.

It is evident, however, that Barrande was disposed at this time to relinquish this term, for in the historical introduction to volume i, the name PHAETONIDES appears as equivalent to PHAETON, but without remark or comment.* This is a part of the work which it is fair to assume was prepared after the body of the text was completed. It was not until 1859 that Barrande formally proposed to replace the term PHAETON with PHAETONIDES.† This author also demonstrated, in 1852, that eight of Corda's proposed species of PRIONOPELTIS, including *P. Priamus* and *P. Polydorus*, were synonymous with his (Barrande's) *Phaeton Archiaci*. This last named species, therefore, becomes the type of the genus PRIONOPELTIS, but the generic term, PHAETON, Barrande, has not the least title to recognition.‡

Angelin, in 1854 and 1878,§ had adopted the term PHAETHONIDES (with this spelling), quoting Barrande as the authority for the name, but including under it not only species with a dentate pygidium, but also those in which the pygidial margin is entire; the only species described by him being one of the latter class, *Asaphus Stokesi*, Murchison. This author's conception of the genus was in one sense essentially equivalent to that of Corda's interpretation of PRIONOPELTIS, since the forms included by the latter in his group B (*P. Ascanius*, *P. Astyanax*) have been proved to possess pygidia with entire margins, and Novák has separated them under the name, TROPIDOCORYPHE (type, *Proetus filicostatus*, Novák). The fossils referred to PHAETHONIDES, Angelin, in the volume of the Palæontology of New York already cited, agree with that author's diagnosis. They all possess entire pygidial margins, though the tubercles with which some are provided, become spinules on the margin and give it the appearance of being dentate. At the same time they are not congeneric with the holopygous species included in Novák's TROPIDOCORYPHE. It is evidently necessary to restrict the term PRIONOPELTIS closely to typical forms agreeing with Barrande's *Ph. Archiaci* and *Ph. striatus*, for Novák has also shown good reasons for separating from this association forms like *Phaeton planicauda*, Barrande, and has given to this restricted group the name, PHAETONELLUS.

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* Page 42.

† Parallèle entre les dépôts siluriens de Bohême et de Scandinavie, p. 18.

‡ We feel compelled to differ from the opinion recently expressed by the late Dr. Novák in regard to this point (Dames and Kayser's Palæontologische Abhandlungen, Neue Folge, Bnd. 1, p. 11, 1890), who speaks of PRIONOPELTIS as "insufficiently characterized," and considers it better to retain PHAETONIDES. It could be wished that genera were as clearly defined in these days as was this genus of Corda's, 45 years ago.

§ Palæontologia Scandinavica, pt. I, p. 21.

The American species have a cephalon with a thickened, usually elevated margin, continued into short genal spines. The surface of the ante-lateral limb is concave, the eyes well forward and close together as in CYPHASPIS. The glabella has the form of that in ARETHUSINA, is short, ovoid, has two conspicuous basal lobes, and bears the trace of a pair of short lateral furrows, which are situated at about the mid-length of the glabella, and under favorable circumstances in an internal cast, are seen to bifurcate slightly at their proximal extremities. The number of the thoracic segments has not been ascertained, but specimens found of *Ph. gemmæus*, of the Hamilton group indicate that the number was not more than ten, and that the forms were proetoid in this respect. The pygidium is always relatively large, subsemicircular in outline, the rhachis and pleura abundantly annulated, from 7 to 12, on the former and from 6 to 8 on the latter. The pleural annulations are subequally duplicate. The rhachis does not extend to the margin. The surface is tubercled, the tubercles being irregularly scattered over the cephalon, and arranged in regular rows on the segments and annulations. These tubercles sometimes take the form of spinules (*Ph. arenicolus*, *Ph. gemmæus*) and extend beyond the margin of the pygidium, but they seem never to have their insertion on the margin itself.

This group of trilobites which we propose to term **CORDANIA** (*Phaethonides cyclurus*, Hall; type), may be said to show alliance to PROETUS in the structure of the pygidium and thorax, to CYPHASPIS in the cephalon generally, and to ARETHUSINA in its glabella in particular. It differs from the TROPIDOCORYPHE of Novák (*Proetus filicostatus*) in the latter having a proetoid, subtriangular glabella, comparatively large and distant eyes, and a pygidium with less conspicuously duplicate annulations and shorter rhachis.

In American faunas this genus is well represented in species, its earliest members being *Cordania cyclura*, Hall (sp.), from the

Lower Helderberg group of New York, and *C. Macrobius*, Billings (sp.), from a similar faunal association at Square Lake, Maine. There is a large undescribed species known to the writer in the Oriskany sandstone of New York; *C. arenicolus*, Hall (sp.), occurs in the Schoharie grit and Corniferous limestone, *C. varicella*, Hall (sp.), in the Corniferous limestone, and *C. gemmæus*, Hall (sp.), in the Corniferous and Hamilton groups. *Asaphus* (*Proetus*) *Stokesi*, Murchison, is probably a member of the same group, and it may be suggested that the pygidium figured by Novák as *Arethusina peltata*, sp. nov., from the Hercynian, possesses a striking similarity to that of CORDANIA.

An interesting species was described by the late Mr. Meek in 1877, from the Devonian of Steptoe Valley, Nevada, under the name, *Proetus* (*Phaeton*) *denticulatus*. The pygidium of this form is short, with a very short, relatively broad rhachis and a row of deep denticulations about the margin. The surface is not otherwise spinous. A glabella found in association with it is distinctly proetoid. Mr. Meek's figures of this fossil were reproduced in the Palæontology of New York, volume vii (pl. xxv, figs. 14, 15), and in the discussion of the species (there referred to PHAËTHONIDES (?)), attention was directed to its similarity in form to *Phaeton planicauda*, Barrande, the species since taken by Novák as the type of his PHAETONELLUS. As the latter genus is now defined, *P. denticulatus* is an excellent representative of it.

PRELIMINARY NOTE.

The following paper may seem out of place in the report of the State Geologist, and its presence in this connection may require some explanation. Since the completion of volume IV, Palæontology of New York, I have contemplated the preparation of illustrated catalogues and handbooks in this department, as a part of the museum publications. This subject had received the special attention and consideration of the trustees during several years previous to 1883. Before this time the means of illustration for the museum reports were irregular and uncertain, depending upon the State Printer, whose contracts for printing were not uniform, sometimes providing for lithographic work, and at others we were without such provision. On this account the scientific contributions to the museum reports were irregular and no plan could be made for carrying out such publications as were required of a museum having the objects and purposes as expressed by the law of 1871, chapter 557. When the law of 1883 was framed, this subject entered into the consideration of the trustees, as shown by the following extract:

* * *; "and the trustees of said museum shall be authorized to publish each year the scientific contributions of said staff and such other original scientific contributions as they may deem expedient, which publication shall be in lieu of the reports now required by law from the State Geologist and State Entomologist, and the scientific papers communicated each year to the Legislature along with the annual report of said trustees;" * * * "and by means of printed handbooks describing said collections, and in such other ways as may be practicable, to make said museum a means of instruction to the citizens of the State."

"In order to provide for the expense of printing the aforesaid scientific publications and in order to increase the usefulness and efficiency of said museum as aforesaid, the annual appropriation to be made for its maintenance shall be fifteen thousand dollars, to be paid on vouchers approved by said trustees."

For the purpose of carrying out this provision of the law the additional sum of $5,000 was added to the previous annual appropriation of the museum. At that time the writer had in preparation and well forwarded a paper upon the genera of the fossil Lamellibranchiata. Also in a forward state of preparation a monograph of the Dictyospongidæ, of which preliminary notices had appeared in the museum reports for 1862 and 1881. The Report for 1862 was published in 1863, and the Report for 1881 was published in 1884; the paper on the Dictyospongidæ having been published in 1882 in advance of the Report. Besides these other papers were in progress corresponding with the subjects uuder investigation for the volumes on the Palæontology.

The monograph upon the Dictyospongidæ, as far as it had progressed, was brought before the Trustees of the State Museum in January, 1885, and the following resolution was passed:

Resolved, That the monograph of Director Hall, on Dictyospongidæ, be published by the museum as Bulletin No. 1.

However, when I asked for the means of completing and publishing the work, it was refused. After the completion of volume V, part I, I brought before the trustees, the subject of a bulletin upon the Genera of Lamellibranchata asking for means of completing the work which had been already carried on to a considerable extent, and ten plates of these illustrations had been already published with my report for 1881. To this application I received a refusal. After this I had in progress and well forwarded, the material for a bulletin upon the Bryozoa, which, at the request of the secretary of the Board of Regents, in 1889, I carried on to near completion at my own expense; but when presented for publication it was refused.

In order to avoid the humiliation of a farther refusal, I have ceased asking for the means of publication, but on several occasions have, brought before the museum committee the drawings of Dictyospongidæ, as far as completed, and also the drawings of fossil Corals, which had been made to the number of at least eighty quarto plates, before the passage of the law of 1883; on each occasion asking for the consideration of the subject, and the suggestion of some plan for their publication.

The bulletins which have been published under the provisions of the law of 1883, are the following:

"**Volume 1.** 6 *nos.* *Price,* $1 *in cloth.*

"1 Marshall, W: B. Preliminary list of New York unionidæ. 19 p. Mar. 1892. *Price,* 5 *cents.*

"2 Peck, C: H. Contributions to the botany of the state of New York. 66 p. 2 pl. May 1887. *Price,* 15 *cents.*

"3 Smock, J: C. Building stone in the state of New York. 152 p. Mar. 1888. *Price,* 30 *cents.*

"4 Nason, F. L. Some New York minerals and their localities. 19 p. 1 pl. Aug. 1888. *Price,* 5 *cents.*

"5 Lintner, J. A. White grub of the May beetle. 31 p. il. Nov. 1888. *Price,* 10 *cents.*

"6 Lintner, J. A. Cut-worms. 36 p. il. Nov. 1888. *Price,* 10 *cents.*

"*Price to advance subscribers,* 50 *cents a volume.*

"**Volume 2.** 4 *nos.* *Price,* $1 *in cloth.*

"The first six bulletins are paged independently; the numbers of v. 2 are paged continuously as a single volume.

"7 Smock, J: C. First report on the iron mines and iron ore districts in the state of New York. 5+70 p. map 58+60 cm. June 1889. *Price,* 20 *cents.*

"8 Peck, C: H. Boleti of the United States. 96 p. Sept. 1889. *Price,* 20 *cents.*

"9 Marshall, W: B. Beaks of unionidæ inhabiting the vicinity of Albany, N. Y. 23 p. 1 pl. Aug. 1890. *Price,* 10 *cents.*

"10 Smock, J: C. Building stone in New York. 210 p. map 58+60 cm. tab. Sept. 1890. *Price,* 40 *cents.*

"11 Merrill, F. J. H. Salt and Gypsum Industries of New York. 89 p. maps. April, 1893. *Price,* 40 *cents.*"

Finding it impossible to obtain publication as I had expected and which had been promised to me before the passage of the law of 1883, I have asked of the Legislature the means of illustrating my annual reports as State Geologist, and the following paper is the first to appear under this authorization. Certainly such a paper would have been more appropriately published as a bulletin of the State Museum of Natural History, but in this direction publication has been persistently refused.

The preliminary work upon the Genera of Lamellibranchiata has not been continued, and the bulletin in preparation ten years ago remains without material progress. The bulletin on the Bryozoa proposed, and prepared for publication in 1888 and 1889 yet remains unpublished. The work upon the Dictyospongidæ, which was originally recommended to constitute bulletin No. 1 of the museum series, has progressed mainly in the direction of the accumulation of material, and the publication of new species in the report for 1889, until the present year. The continuation of the present paper upon the Brachiopoda is already far advanced and it is expected that it will be published in the annual report of the State Geologist for 1893. The second part will include the spire-bearing genera, the Rhynchonellidæ, Pentameridæ and the Terebratuloids.

With a continuation of the present provisions for illustrating the report of the State Geologist, we may hope within a few years, to retrieve in some measure, the loss of time and publication, suffered during the past ten years.

AN INTRODUCTION

TO THE STUDY OF

THE BRACHIOPODA

INTENDED AS

A HAND BOOK FOR THE USE OF STUDENTS.

By James Hall, assisted by John M. Clarke.

PREFACE.

The accompanying paper has been communicated as a part of and to the report of the State Geologist with the object of presenting to the public an example of the kind of work I had proposed to do under the provisions of the law of 1883, which appropriated the sum of $5,000 annually for the purposes of publishing the "scientific contributions" of the "museum staff and such other scientific contributions as they," the trustees, "may deem expedient; and by means of printed handbooks describing said collections and, in such other ways as may be practicable, to make the said museum a means of instruction to the people of the State."

It had long been my desire to accomplish by some means a diffusion of the knowledge of the Palæontology of the State as a guide and help to students in geology in our colleges and higher schools. In the earlier work of the Palæontology of the State, when the publications were compelled to follow immediately upon the acquisition of fossils from the field, it was necessary to include all the classes of organisms from the formation, or series of formations, under discussion, and, therefore, the earlier volumes present only a very partial attempt at a biological arrangement of the material. As soon as collections had accumulated to such a degree as permitted the treatment of each class of fossils, from one or several formations, in their biological relations they were so discussed and illustrated.

It was not until the time of the publication of the fourth volume upon the Devonian Brachiopoda that such a method of treatment could be adopted, and during this work I became more fully aware than ever before of the necessity of preparing an epitome or synopsis of that volume, and also including the preceding volumes, so far as related to the brachiopoda, which might bring before the student a clearer appreciation of the generic features of this class of fossils. With this idea in mind arose the conception of treating this subject in the order of geologic time. To one who had worked among the fossils of the older rocks upward through all the formations to the Carboniferous, it was impossible to avoid the conviction that the modification of similar forms in successive geologic periods, and the final disappearance of some of them, either from slow degeneration, or after extravagant manifestations of certain characters, had a significance which had not been fully understood or appreciated by writers upon this class of fossils.

With this conception in mind I began the preparation of what was then intended to be a supplement to Volume IV of the Palæontology of New York. After waiting for more than twenty years for the means of making the necessary collections and for publication, this supplement has expanded into volume VIII, parts i and ii of the Palæontology of New York. From the studies carried forward among the brachiopoda in preparing these volumes has come back to the writer more strongly than ever the importance of preparing a synopsis of the genera which may form a useful handbook for advanced students in geologic studies.

Through the action of an intelligent Legislature and the appreciation of a wise Executive, means have been furnished for making this publication.

The discussions of the genera and their relations are the same as those given in the volumes just named, with corresponding illustrations.

In order to present the subject to the student, in not too abrupt a manner, it has seemed necessary to precede the generic discussions by some general elementary explanations.

There is at present no work in the English language meeting the modern requirements of a guide or introduction to the study of the Brachiopoda in which elementary facts in regard to structure, function, habits and distribution of these animals, the distinguishing characters and systematic relations of their genera, are concisely brought together in one place. The literature pertaining to both recent and fossil forms is widespread and in many languages, beyond the reach of most students, and sometimes accessible with difficulty even to investigators. Dr. Œhlert has admirably summarized the subject in Fischer's Manual de Conchyliologie (1887) and Prof. von Zittel has treated the group still more succinctly in his "Handbuch von Paläontologie." In bringing to a summary the investigations of the palæozoic genera of the brachiopoda as expressed at length in volume VIII, parts i and ii of the Palæontology of New York, it has seemed desirable to present to students an abridgment of the conclusions there derived, with the addition of some introductory and more general descriptive matter. The outcome of this purpose is the present work which it is hoped and believed will be found serviceable to students of both palæontology and geology, and help to nourish the growing interest in the structure and history of these important animals. The work has been prepared for the use of American students to whom it is cordially dedicated.

JAMES HALL,

State Geologist.

1891. 18 5

THE BRACHIOPODA.

GENERAL CHARACTERS OF THE CLASS.

The BRACHIOPODA are marine animals inclosed in bivalved, equilateral and inequivalved shells.

As a group they attained a most prolific and multiform development during the Palæozoic and Mesozoic eras in the history of the earth, while their existing representatives are comparatively few in number. A knowledge of their variations in form, structure and in time is, therefore, of highest importance to the student of biology and geology.

In brief, these animals are characterized by the unequal development of the two lobes of the cuticular integument (*mantle*), which results in the unequal size of the valves. The mouth is situated subcentrally or posteriorly and is surrounded by elongated, usually spiral cirrated expansions, which occupy the anterior portion of the valves and serve as conveyancers of food-bearing water-currents; in part, also, subserving the function of respiration. There is a simple œsophageal nerve-ring with an inferior or sub-œsophageal ganglion, and various small accessory nerve-knots. The sexes are distinct in all species in which these characters have been studied.

HABITS OF LIFE. From our knowledge of existing species it is believed that all Brachiopoda, at some period of their existence, are attached to extraneous objects. To this statement, there is but one known exception among living forms, namely, the linguloid, *Glottidia Audebardi.* In the fossil (Palæozoic) genera PHOLIDOPS and PSEUDOCRANIA there is no evidence of attachment of any kind, either in the young condition (PHOLIDOPS), or in the mature and senile stages of growth.

Fixation is usually effected by means of a fleshy arm or pedicle of greater or less length, protruded through an aperture at, or near the apex of the larger valve. In certain genera, however, fixation is attained by the cementation of the lower valve (CRANIA), or of the umbonal portion of the larger valve (STROPHALOSIA, DAVIDSONIA, LEPTÆNISCA, CHONOPECTUS, etc.) to the external object.

FIG. 1.—*Derbya Bennetti.* An adult example in which the scar of attachment (x) is retained. A *Crania* is attached to the umbo of the brachial valve.

The former mode of attachment takes place at an early stage in the growth of the animal, and is continued in some instances throughout the remainder of its life (TEREBRATELLA, MAGELLANIA, HEMITHYRIS, etc.); at other times the pedicle becomes atrophied after adolescence or maturity, by the incurvature of the beak of the larger valve, or by the closing of the aperture for its passage by adventitious deposits of calcareous matter, and the shell thus becomes free. This condition is true of some living genera, while it obtained among the majority of Palæozoic species,

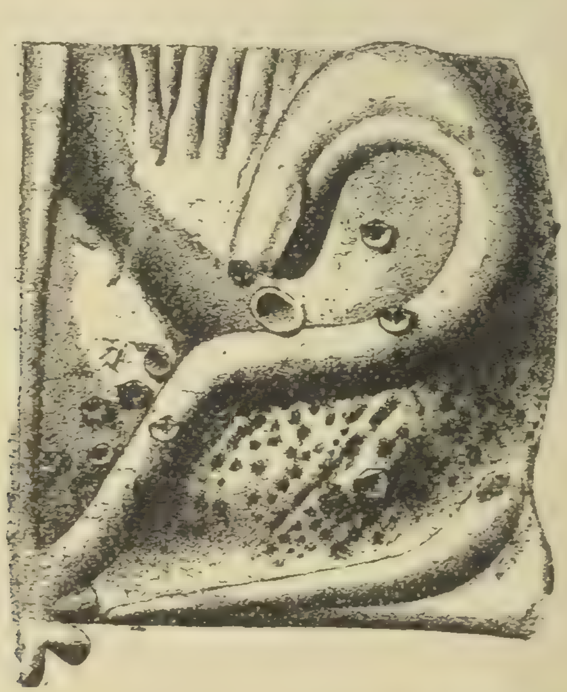

FIG. 2.—A portion of the inner surface of a brachial valve of *Productus*, to which a number of very young shells of *Derbya* are attached by the cementation of the pedicle-valve. It will be observed that most of the attached shells have the hinge line parallel to that of the *Productus*, though their relative positions are inverted.

especially those of the genera STROPHOMENA, RAFINESQUINA,* STROPHEODONTA, LEPTÆNA, PLECTAMBONITES, CHONETES, PRODUCTUS, etc.

Fixation by calcareous cementation also began early in life, and in CRANIA, DAVIDSONIA, LEPTÆNISCA and RICHTHOFENIA, continues during the remainder of the animal's existence, the attached valve frequently being fixed by its entire outer surface. In other genera the condition of attachment was restricted to early, or adolescent growth stages; (ORTHOTHETES, DERBYA, STROPHALOSIA, OLDHAMINA, etc.),† the shell in after life becoming detached from its mooring, but usually retaining a scar or deformation of the surface in the umbonal region. Attachment by cementation has been shown by JACKSON to induce among the Lamellibranchiates a strongly vescicular structure in the attached shell; and it may be a rule of more general application, as it is seen in certain attached annelidan tubes, e. g., *Cornulites proprius;* and among those brachiopods which are attached by a considerable surface of the shell, such as CRANIA and, especially, the extravagant RICHTHOFENIA, the vesciculation of the shell-structure is a striking feature.

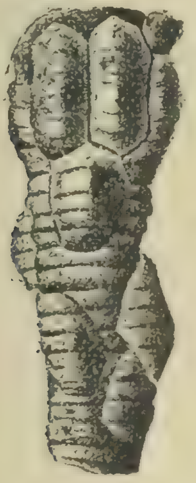

FIG. 3.—A fragment of a crinoid column covered with a number of individuals of *Crania socialis*, which retain the marks of the sutures between the segments of the crinoid.

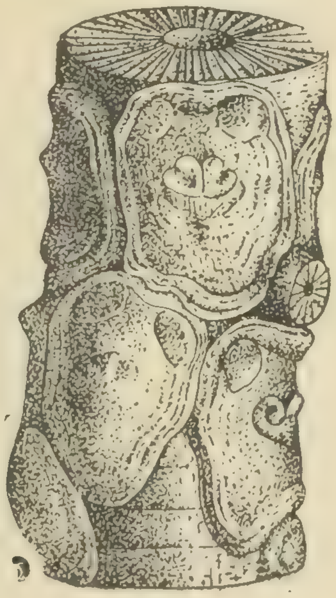

FIG. 4.—Lower valves of *Crania quadrata* attached to column of a crinoid, the upper valves having been removed by natural causes (DAVIDSON).

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* Not infrequently in STROPHOMENA and RAFINESQUINA a minute pedicle-passage is retained in the mature condition of the shell, but it is always evident that the shell could not, at this period of growth, have been supported by any muscular apparatus which might be protruded through this aperture. In *Rafinesquina alternata*, of the Lower Silurian, it is seen that the contraction of the aperture has increased most rapidly about the base of the pedicle, and the internal opening of the passage may be altogether closed, while the external opening remains.

† *Craniella Ulrichi*, of the Lower Silurian, is the only inarticulate brachiopod which appears to have been thus attached in early growth and to have become free at maturity.

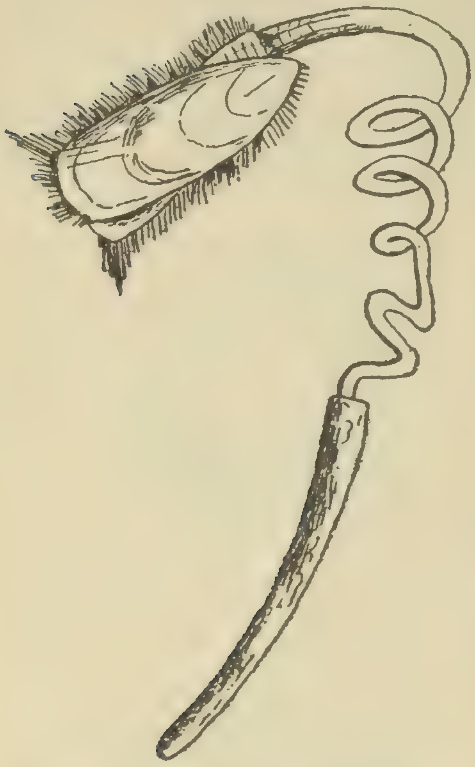


FIG 5 — *Glottidia Audebardi* (MORSE).

Glottidia Audebardi has been mentioned as a species in which attachment exists at no stage of development. The muscular pedicle of the animal penetrates marine sediments and gathers about itself a mass of agglutinated grains of sand, fragments of shell and bits of sea-weed, forming thus a distinctly free capsule or tube, after the manner of many worms. This may be regarded as a sort of attachment, as the animal, after the formation of this tube, is at no time free from it.

In the genus STROPHALOSIA, the attachment by the substance of the valve was frequently aided by the long spines with which the attached valve is furnished, these adhering to, or embracing the foreign object. An individual of *Strophalosia radicans*, having become lodged in the cavity between the calyces of a compound coral (*Acervularia*), has anchored itself essentially by its spines alone, only the posterior edge of the valve coming into contact with its host.

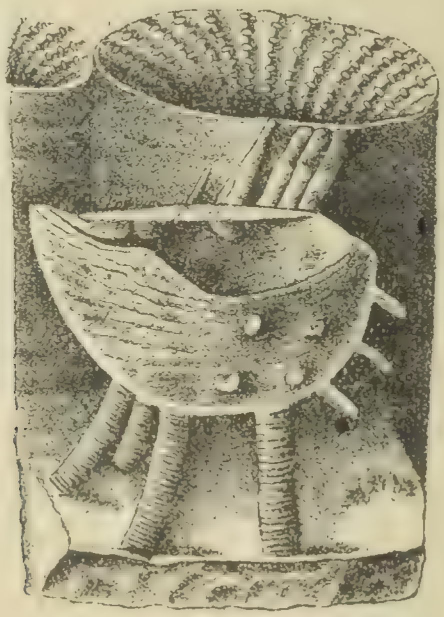


FIG. 6 — *Strophalosia radicans*, situated in a cavity between the calyces of *Acervularia*, and attached by its spines. X 3.

ETHERIDGE has described some small productoids (*Etheridgina complectens*), which are attached to columns of crinoids by the encircling of the spines, as though at some time these spines had been flexible and prehensile organs. The same author also mentions a species of CHONETES apparently attached by the spines on the cardinal margin, but this observation seems to require verification. *Productella navicella*, of the Devonian, has the spines in the umbonal region of the large valve curved upward, those from opposite sides passing each other; like a man's arms extended and folded above his head. These were undoubtedly clasping or anchoring spines.

It is even possible that *fixation by mooring*, or temporary attachment was effected by an extravagant growth and enfolding of the anterior portions of the larger valve, in some Carboniferous productoids (PROBOSCIDELLA) which have been described by DE VERNEUIL, DE KONINCK, DAVIDSON and others.

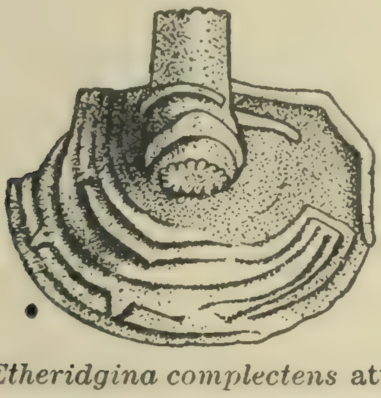


FIG 7.—*Etheridgina complectens* attached by its spines to a crinoid column. (ETHERIDGE.)

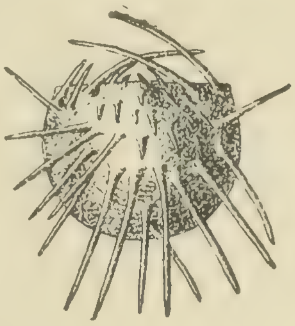


FIG. 8—*Productella navicella*, showing the clasping spines in the umbonal region Hamilton group; New York.

The capability of locomotion in the brachiopods was very limited. During the unattached condition the spawn were active swimmers. TEREBRATULINA becomes attached very early in its history, while DISCINSCA is fixed only after many of the adult characters have been assumed. It is difficult to believe that any power of locomotion was possessed by the ancient forms in which the pedicle was atrophied at maturity and the shell thus set free, as SPIRIFER, PRODUCTUS, some forms of ATHYRIS, etc.; or that the animals could depend on other than circumstantial causes for a change of place. Some writers have suggested that the long spines with which several genera, especially PRODUCTUS, are furnished, may have been aids to such motion, but as these spines were unquestionably rigid bodies, it is difficult to believe that they could have had any part in the voluntary motion of the animal.

DISTRIBUTION. The brachipods are gregarious in habit and over a given area of the sea-bottom a single species will frequently be found in great numbers. "Prof. JUKES got immense numbers of *Waldheimia flavescens* or *australis* while boating in Australia among the reefs. M. Vélain picked up a small species of KRAUSSINA in vast numbers on the shore in the interior crater of the island of St. Paul, the shells being alternately covered with water and left dry at every tide. *Kraussina rubra*, from the coast of Natal in South Africa, was described by Dr. Gray as having been found attached in great numbers to Ascidia and stems of sea-weeds" (DAVIDSON). It is said that more than twenty bushels of *Lingula anatina* were picked up after a violent storm on the coast of Manilla, and ŒHLERT states that on the coast near Guernsey were found at one time about two hundred specimens of *Cistella cistellula*.

Some of the genera and species of brachiopods possess remarkable power of resistance to physical conditions, and are found at various depths. The genus DISCINISCA has representatives within five fathoms of the surface and at a depth of 2,500 fathoms; the species *Terebratulina caput-serpentis* ranges from near the surface to a depth of 1,195 fathoms. The greatest depth from which any species has been dredged is 2,945 fathoms (*Liothyrina Wyvillii*).

The evidence afforded by living species is as yet insufficient to determine the effects of bathymetric conditions upon specific characters. It is evident that different species are variously affected or inequably resistant to these influences; but as a general rule, different species or associations of species are found at different depths.

In the summary of bathymetric distribution of living species as given by ŒHLERT, it appears that in the *Littoral Zone*, or that between tides, there are 17 known species, 7 of which are peculiar to it; in the *Laminarian Zone* (to a depth of 15 fathoms), there are 46 species, 15 of which are peculiar to it; in the *Zone of Nullipores* (from 15 to 50 fathoms) are 39 species, of which but 3 are restricted to it; in the *Zone of Brachiopods* (from 50 to 278 fathoms), 58 species have been found, and 20 of these are not known elsewhere; in the *Abyssal Zone* (from 278 to 2,945 fathoms) have been found 30 species, of which 12 do not occur elsewhere. It is, however, to be observed that in these conventional divisions the so-called restricted species occur either in zones of great vertical extent or those where organic life generally is the most prolific. There is no evidence that this bathymetric range of the brachiopods has been effected by any other causes than restricted powers of self-distribution, in co-operation with a given capacity of resistance to physical forces.

An important factor in their distribution is the influence of heat and cold, to which the brachiopods are evidently sensitive; a fact which makes itself apparent in their geographical dissemination. There are some species (*Hemithyris psittacea*, *Liothyrina arctica*, *Terebratella Spitzbergensis*) which flourish best in the cold waters about the north pole, and never transgress into the warmer seas where the brachiopods are most prolific. At the same time there are a few species that are world-wide in their distribution (*Liothyrina vitrea*, var. *minor*, *Terebratulina caput-serpentis*), and, as ŒHLERT observes, these are species which also possess the greatest bathymetric range.

The following table of the *Geographical Provinces* and the species embraced within them has been largely drawn from that compiled by ŒHLERT in FISCHER's *Manuel de Conchyliologie*. This may be studied in connection with the accompanying map of the World, upon which is plotted the distribution of living species.

ARCTIC PROVINCE:

Atretia gnomon.
Crania anomala.
Discinisca atlantica.
Liothyrina arctica.
Macandrevia cranium.
Dallina septigera.
Magellania tenera.
Rhynchonella (Hemithyris) psittacea.
Terebratalia frontalis.
Terebratella Spitzbergensis.
Terebratulina caput-serpentis.

BOREAL PROVINCE:

Atretia gnomon.
Cistella cistellula.
Crania anomala.
" " var. *alba.*
Laqueus Californicus (Megerlina Jeffreysi.)
Macandrevia cranium.
Dallina septigera.
Rhynchonella (Hemithyris) psittacea.
Terebratella Frielii.
T. Labradorensis.
T. Spitzbergensis.
Terebratalia transversa.
Terebratulina caput-serpentis.
T. unguiculata.

LUSITANIAN PROVINCE:

Cistella cistellula.
C. cuneata.
C. neapolitana.
Crania anomala.
Discina striata.
Discinisca atlantica.
Eucalathis ergastica.
E. Murrayi.
E. tuberata.
" " var. *mediterranea.*
Gwynia capsula.
Liothyrina sphenoidea.
L. vitrea.
" " var. *minor.*
Macandrevia cranium.
Dallina septigera.
Megathyris decollata.
Mühlfeldtia truncata.
" " var. *monstruosa.*
Platidia anomoides.
P. Davidsoni.

Platidia lunifera.
Rhynchonella (Hemithyris) cornea.
Terebratulina caput-serpentis.
T. trigona.

West African Province:

Dyscolia Wyvilii.
Discina striata.
Lingula parva.
Liothyrina sphenoides.
Mühlfeldtia incerta.
Rhynchonella (Hemithyris) cornea.
Terebratulina caput-serpentis.

South African Province:

Agulhasia Davidsoni.
Kraussina cognata.
K. Davidsoni.
K. pisum.
K. rubra.
Liothyrina vitrea var. *minor.*

Indo-Pacific Province:

Discinisca stella.
Lingula affinis.
L. anatina.
L. hians.
L. hirundo.
L. Reevii.
Liothyrina vitrea, var *minor.*
Mühlfeldtia sanguinea.
M. truncata.
Rhynchonella (Hemithyris) Grayi.
Terebratella Frielii.
Terebratulina Cumingi.
T. japonica.
T. Murrayi.

Australo-Zealandian Province:

Crania Suessi.
Kraussina Atkinsoni.
K. Lamarckiana.
Lingula exusta.
L. Murphiana.
L. tumidula.
Liothyrina Wyvillii.
Magasella Evansi.
M. fibula.
M. inconspicua
Magellania flavescens
M. lenticularis.
Mühlfeldtia truncata.
M. Willemoesi.
Rhynchonella (Hemithyris) nigricans.
Terebratella cruenta.
T. rubicunda.
Terebratulina cancellata.

Japanese Province:

Crania japonica.
Discinisca stella.
Laqueus pictus.
L. rubella.
Lingula Adamsi.
L. jaspidea.
L. lepidula.
L. smaragdina.
Liothyrina Dalli.
L. vitrea var. *Davidsoni.*
Macandrevia cranium.
Magasella Adamsi.
M. Gouldi.
Magellania Grayi.
Dallina Raphaelis.
Mühlfeldtia sanguinea.
Rhynchonella (Hemithyris) Döderleini.
R. lucida.
R. psittacea.
Terebratalia coreanica.
T. frontalis.
Terebratella Mariæ.
T. Spitzbergensis.
Terebratulina caput-serpentis.
T. Crossii.
T. Cumingi.
T. japonica.
T. radiata.

Aleutian Province:

Magasella aleutica.
M. radiata.
Rhynchonella (Hemthyis) psittacea.
Terebratalia frontalis.
Terebratella Lamanoni.
T. transversa.
Terebratulina unguiculata.

Californian Province:

Glottidia albida.
G. Palmeri.
Laqueus californicus.

Liothyrina Stearnsi.
Platidia anomoides.
Terebratalia obsoleta.
T. occidentalis.
Terebratella transversa.
Terebratulina unguiculata.

PANAMIC PROVINCE:

Discinisca Cumingi.
D. lamellosa.
Glottidia Audebardi.
G. semen.
Liothyrina uva.

PERUVIAN PROVINCE:

Discinisca Cumingi.
D. lævis.
D. lamellosa.
Liothyrina Wyvillii.
Magellania Wyvillii.
Terebratalia dorsata.

MAGELLANIAN PROVINCE:

Liothyrina Moseleyi.
L. Wyvillii.
Magasella flexuosa.
M. lævis.
M. rhombea.
Magellania Kerguelenensis.
M. venosa.
Platidia anomoides.
Rhynchonella (Hemithyris) nigricans.
Terebratalia dorsata.
Terebratella pulvinata.
Terebratulina Murrayi.
T. septentrionalis.

PATAGONIAN PROVINCE:

Liothyrina uva.

CARIBBEAN PROVINCE:

Bouchardia rosea.
Cistella Barrettiana.
C. lutea.
C. Schrammi.
C. Schrammi var. *rubrotincta.*
Crania Pourtalesi.
Discinisca Antillarum
D. Cumingi.
Discolia Wyvillii.
Glottidia Antillarum.
G. pyramidata.
Liothyrina Bartletti.
L. incerta.
L. Moseleyi.
Platidia anomoides.
Terebratulina Cailleti.
T. caput-serpentis.
Thecidium mediterraneum.

TRANSATLANTIC PROVINCE:

Crania Pourtalesi.
Discinisca atlantica.
Glottidia pyramidata.
Dallina floridana.
Platidia anomoides.
Terebratulina Cailleti.
T. septentrionalis.

EXPLANATION OF MAP.

The geographical position of each species is represented by a black circle inclosing a number, which refers to the following alphabetical list of names:

(The fact is recognized that some of the names here employed probably represent developmental phases of other species, but as it is impossible with our present knowledge to ascertain of how many such names this is true, the commonly accepted designations are therefore employed.)

1. Agulhasia Davidsoni.
2. Atretia Brazieri.
3. A. gnomon.
4. Bouchardia rosea.
5. Cistella Barrettiana.
6. C. cistellula.
7. C. cuneata.
8. C. Kowalevskii.
9. C. lunifera.
10. C. lutea.
11. C. neapolitana.
12. C. Schrammi.
13. " " var. rubrotincta.
14. C. Woodwardiana.
15. Crania anomala.
16. " " var. alba.
17. C. japonica.
18. C. Pourtalesi.
19. C. Suessi.
20. C. turbinata.
21. Discina striata.
22. Discinisca Antillarum.
23. D. atlantica.
24. D. Cumingi.
25. D. lævis.
26. D. lamellosa.
27. D. stella.
28. Dyscolia Wyvillii.
29. Eucalathis ergastica.
30. E. Murrayi.
31. E. tuberata.
32. " " var. mediterranea.
33. Glottidia albida.
34. G. Antillarum.
35. G. Audebardi.
36. G. Palmeri.
37. G. pyramidata.
38. G. semen.
39. Gwynia capsula.
40. Kraussina Atkinsoni.
41. K. cognata.
42. K. Davidsoni.
43. K. Deshayesi.
44. K. Lamarckiana.
45. K. pisum.
46. K. rubra.
47. Laqueus californicus.
48. " " var. Vancouverensis.
49. L. pictus.
50. Lingula Adamsi.
51. L. affinis.
52. L. anatina.
53. L. exusta.
54. L. hians.
55. L. hirundo.
56. L. jaspidea.
57. L. lepidula.
58. L. Murphiana.
59. L. parva.
60. L. Reevii.
61. L. smaragdina.
62. L. tumidula.
63. Liothyrina arctica.

64. Liothyrina sphenoidea.
65. L. subquadrata.
66. L. vitrea.
67. " " var. cernica.
68. " " " Davidsoni.
69. " " " minor.
70. L. Wyvillii.
71. Macandrevia cranium.
72. Magasella Adamsi.
73. M. aleutica.
74. M. crenulata.
75. M. Evansi.
76. M. fibula.
77. M. flexuosa.
78. M. Gouldi.
79. M. incerta.
80. M. inconspicua.
81. M. Labradorensis.
82. M. lævis.
83. M. patagonica.
84. M. radiata.
85. M. rhombea.
86. Magellania flavescens.
87. M. (Dallina) floridana.
88. M. (Dallina) Grayi.
89. M. Kerguelenensis.
90. M. lenticularis.
91. M. (Dallina) Raphaelis.
92. M. (Dallina) septigera.
93. M. tenera.
94. M. venosa.
95. M. Wyvillii.
96. Megathyris decollata.
97. Mühlfeldtia echinata.
98. M. incerta.
99. M. sanguinea.
100. M. truncata.
101. M. " var. monstruosa.
102. M. Willimoesi.
103. Platidia anomioides.
104. P. Davidsoni.
105. P. lunifera.
106. Rhynchonella cornea.
107. R. Döderleini.
108. R. Grayi.
109. R. lucida.
110. Rhynchonella nigricans.
111. R. " var. pyxidata.
112. R. psittacea.
113. Terebratella Blanfordi.
114. T. (Terebratalia) coreanica.
115. T. cruenta.
116. T. (Terebratalia) dorsata.
117. T. Frielii.
118. T. (Terebratalia) frontalis.
119. T. Gouldi (=78).
120. T. Labradorensis.
121. T. Lamanoni.
122. T. Mariæ.
122*a*. T. (Terebratalia) obsoleta.
123. T. (Terebratalia) occidentalis.
124. T. pulvinata.
125. T. rubicunda.
126. T. rubiginosa.
127. T. Spitzbergensis.
128. T. (Terebratalia) transversa.
129. Terebratula (Liothyrina) Bartletti.
130. T. (L.) Dalli.
131. T. (L.) incerta.
132. T. (L.) Moseleyi.
133. T. (L.) Stearnsi.
134. T. (L.) uva.
135. Terebratulina Cailleti.
136. T. cancellata.
137. T. caput-serpentis.
138. T. (Dyscolia) Crossii.
139. T. Cumingi.
140. T. japonica.
141. T. Murrayi.
142. T. radiata.
143. T. septentrionalis.
144. T. trigona.
145. T. unguiculata.
146. Thecidium Barretti.
147. T. (Lacazella) mediterraneum.

COLOR.

The shells of most living species are of light or neutral tints, white or horn-color. The deep-sea species are usually vitreous, translucent and very thin-shelled. A deep orange-red in radiating bands or in solid tints, colors some species (TEREBRATULINA, KRAUSSINA, etc.); light yellows, deep and light shades of green (LINGULA), black in bands (CRANIA) or masses (RHYNCHONELLA) embellish these shells. Even among the fossil species traces of faded color-marks are occasionally observed; DESLONGCHAMPS has described them among Jurassic species, DAVIDSON among the Carboniferous, and KAYSER has found a color-marked RHYNCHONELLA in the Devonian. The large, highly ornamented species of Palæozoic times, with their external sculpture heightened by a brilliant coloring must have been objects of exquisite beauty.

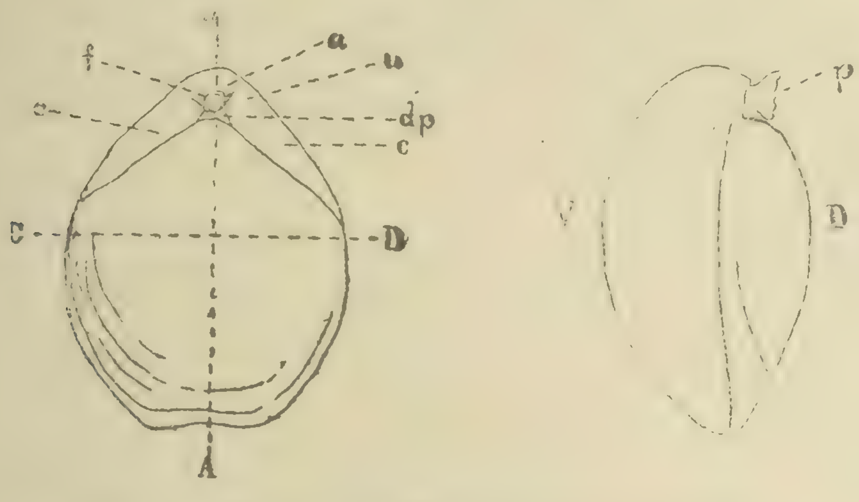
THE SHELL.

External Form and Terminology of its Parts.

The brachiopod shell assumes a great variety of forms. Usually both valves are more or less convex, but they may be almost flat, and one of them is frequently concave, following the curvature of the other. In early age the surface of all is normally smooth, and while many retain this smoothness throughout their existence, the greater number bear radial ribs or plications, or a series of concentric varices and growth-lines.

The valve, which, in youth or maturity, bears at or near its apex, a perforation or fissure, is known as the *pedicle-valve*, as it is through this opening that the pedicle or fleshy arm of attachment is protruded, being attached to the inner surface of the valve by a series of muscular bands. This valve has also been quite generally known as the *ventral*, as it may, from certain considerations, be regarded as lying on the ventral side of the animal. It is usually the larger of the two valves, and has, therefore, been designated by many writers as the *larger valve*; but there is so great a number of instances in which the pedicle-valve is not the larger, that this term is objectionable. This valve bears the teeth or the principal articulating apophyses of the hinge, and has hence been termed the *dental valve*; an unsatisfactory designation, as a vast number of species is provided with no such apparatus. A few writers have called it the *neural* *valve*, because of the location of the principal nerve-ganglia on this side of the body.

The opposite, usually smaller and imperforate valve, is known as the *brachial valve*, as to it are attached the spiral arms or brachia. This is the *dorsal*, *socket* or *hæmal valve* of some writers.



FIGS. 9.—Front and profile views of *Terebratula*.

These valves usually have an articulated *hinge* situated beneath the beaks; sometimes they are held together in simple apposition by muscular contraction, but whenever, and to whatever extent the valves are opened by the animal, the basis of the movement is at this posterior margin of the shell.

In discussing the shells of the brachiopods a simple nomenclature has been adopted.

Most writers are agreed in orienting a shell with its beaks upward. That portion of the valves thus lying above a horizontal axis (C—D) passing through the center of the valves, is the *posterior portion*, that below this axis the *anterior portion*. The shell is also divided by a vertical axis (A–B) into equal *lateral parts*. The *apex* of the valves is their acute or obtuse point of

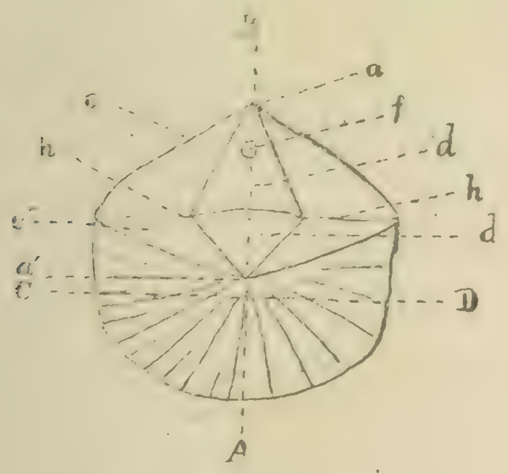


FIG. 10.—*Orthisina*.

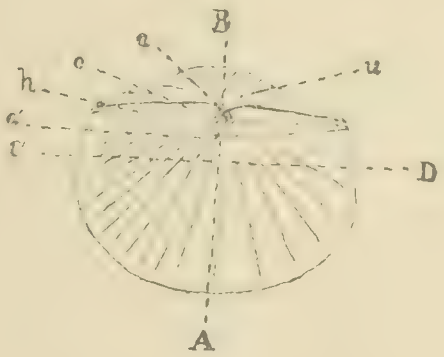


FIG. 11.—*Plectambonites*.

beginning (a, á), the *umbo* (u), the more prominent portion or *beak* including the apex; the *umbonal slopes* are the inclined surfaces about the umbo, except those extending to the hinge margins, which are known as the *cardinal slopes* (c). The *hinge-line* (h) is the straight or curved line along which articulation takes place; the *cardinal extremities* (e) the exsert terminations of this line; the *cardinal area* (c, ca), a triangular vertical or curved surface, distinctly set off from the general surface of the shell and more highly developed on the pedicle-valve. This cardinal area is transsected by a median triangular aperture having its apex at the apex of the pedicle-valve, its base at the hinge-line; this is called the *delthyrium* (dt) and in function it is a passage for the pedicle.

This aperture is usually closed or covered at some period in the history of the organism; in the earliest growth-stages of the shell, and in primitive genera, it is covered by a single convex plate or sheath, known as the *deltidium* (d). In secondary or derived genera (RHYNCHONELLA, SPIRIFER, ATHYRIS, TEREBRATULA) the deltidium disappears by resorption, at a very early stage of growth, or is never present, and the delthyrium may remain open for a considerable period in the life of the animal; but it eventually becomes more or less completely closed by the gradual formation, along the lateral margins of the delthyrium, of two separate plates (*deltidial plates*, dp), which in the adult condition may either remain discrete or unite along the median line, or having thus united, become coalesced into a single plate (SPIRIFER, CYRTINA), which has the form of a deltidium but is wholly distinct in origin. Both deltidium and deltidial plates may enclose an oval or circular passage or *foramen* (f) for the protrusion of

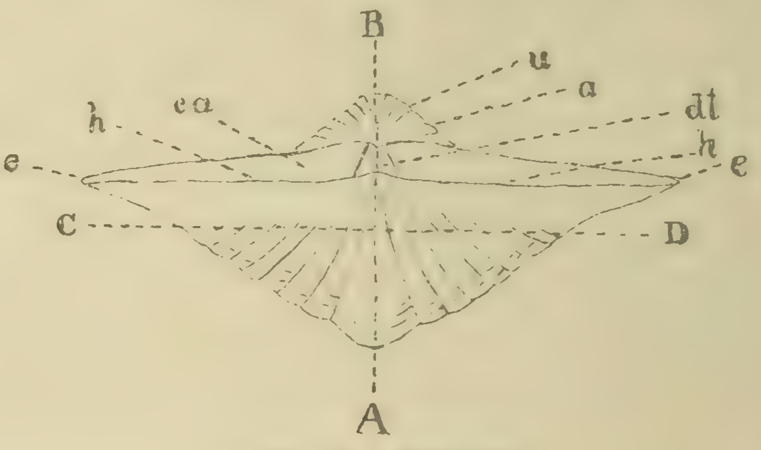
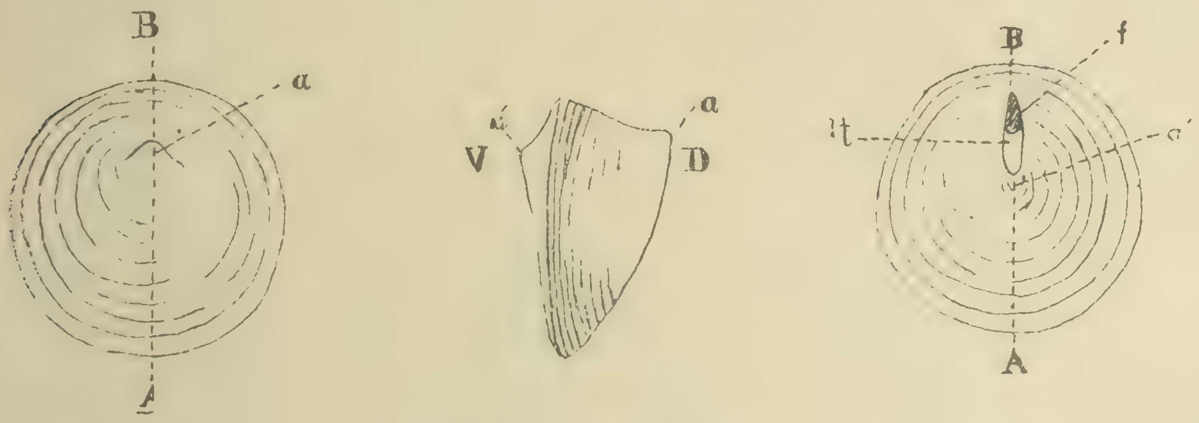


FIG. 12.— *Spirifer.*

the pedicle; in the former the foramen is usually apical, but in the latter it generally lies below the apex, and in both cases it may become entirely obliterated by the later growth of the shell. Likewise both deltidium and deltidial plates may be resorbed in the senile stages of growth.

In some of the edentulous genera, as ORBICULOIDEA and SCHIZOTRETA, a structure somewhat analogous to the deltidium is formed between the apex of the pedicle-valve and the opening for the pedicle, and this area becomes modified by the passage of the pedicle over its surface. It is important to distinguish this from the deltidium of the articulate genera, and it may be termed a *listriate deltidium* or *listrium* (lt).



FIGS. 13.— *Orbiculoidea.*

Pedicle valve. Profile. Brachial valve.

V. pedicle-valve; D. brachial valve; *a.* apex of brachial valve; *a′* apex of pedicle valve; *f.* foramen; lt. listrium.

It is probably true that in the very early growth stages of all brachiopods, the posterior margin of *both valves* was grooved for the passage of the pedicle. This is to some extent the condition in the adult LINGULA, OBOLUS and OBOLELLA. With the reduction in the relative size of the pedicle, and its restriction to the larger valve, the primitive aperture in the brachial valve was closed by a transverse plate similar in appearance to the deltidium, and in function (to close a discarded or abbreviated passage) to the deltidial plates of the opposite valve. This plate was not formed by the secretion and union of distinct lateral plates but by a

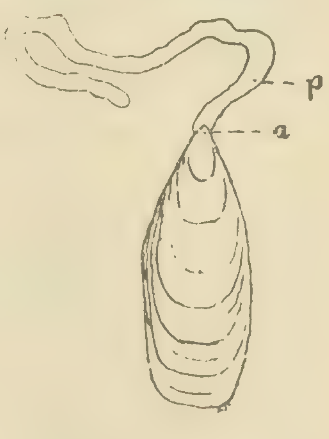


FIG. 14 — *Lingula.*
a. Apex of pedicle valve: *p.* pedicle.

general deposition about the margins of the aperture from the apex downward. This plate has been termed the *chilidium* (d′) and has been shown to be of secondary growth.

Variations in Form.

The forms assumed by the brachiopods are so diverse that it is often difficult to believe that shells so unlike in contour belong to the same natural group. The habits of these animals and the workings of natural causes in the modification of their shells afford a very substantial aid to the comprehension of these differences.

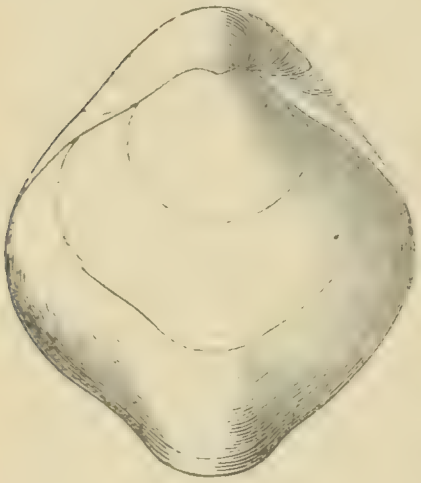


FIG. 15.— *Meristella nasuta.*

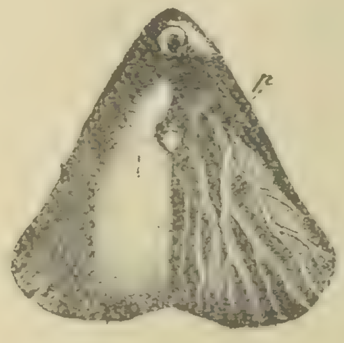


FIG. 16.— *Pygope diphya.* *p.* Vascular sinuses.

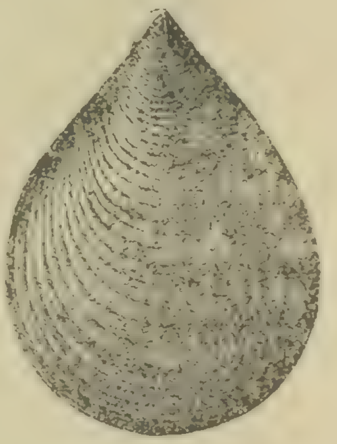


FIG. 17.— *Lingula paliformis.*

(DAVIDSON.)

The youngest shells of all Brachiopoda (so far as they have been studied) are biconvex and sub-semicircular in outline. Those shells in which the pedicle retains its functions until maturity (LINGULA, TEREBRATULA, MAGELLANIA, RHYNCHONELLA, etc.) and hang freely suspended from the point of attachment, are oval and biconvex throughout their existence. In such shells as LINGULA

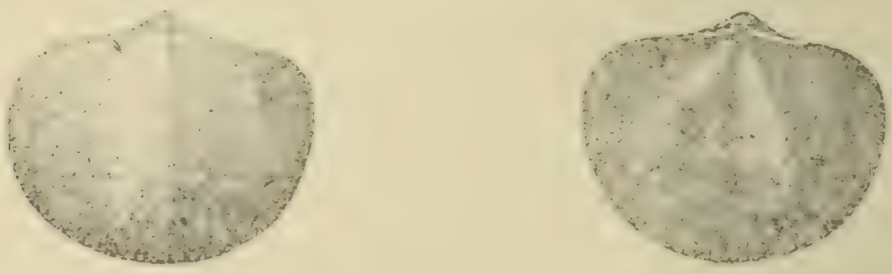


FIG. 18.— *Orthis subcarinata.*

and OBOLUS, and the early growth stages of many genera where the pedicle is long and flexible, produced in the vertical axis of the animal, and at the same time not restricted in its passage to one valve, the differences in the form of the two valves are at their minimum, as they are more equably exposed and resistant to external physical impacts. Where there is a decided inequality in the valves, it has been observed in living forms, and is probably equably true of fossil species, that the pedicle is short, rigid and restricted to one valve; and there thus appears to be a certain definite relation between the angle at which the pedicle is protruded and the size of the valves. The pedicle-valve, which, typically, in the adult condition is the larger, is the seat of the principal muscular activity and the main lodgment of the viscera; it is, in a certain sense, the cell of habitation of the animal, and

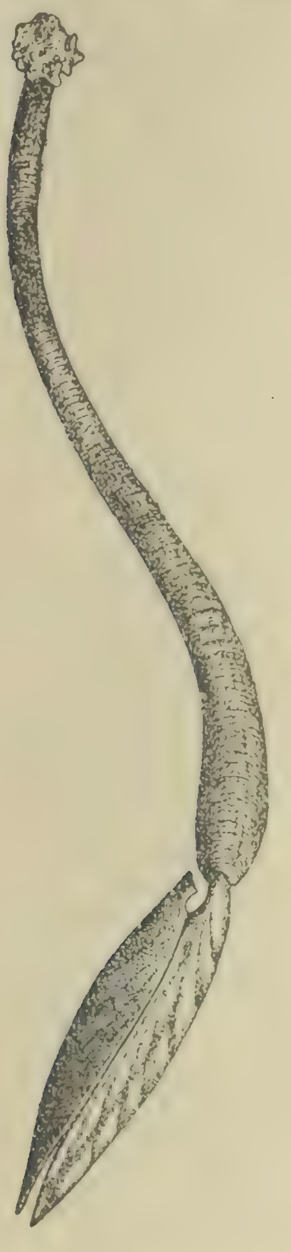


FIG. 19.— *Lingula Murphiana.* (DAVIDSON.)

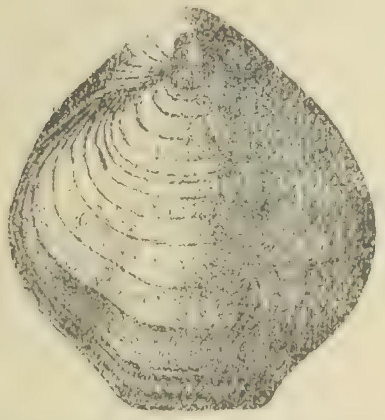


FIG. 20.— *Athyris subtilita.*

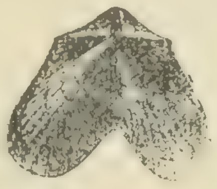
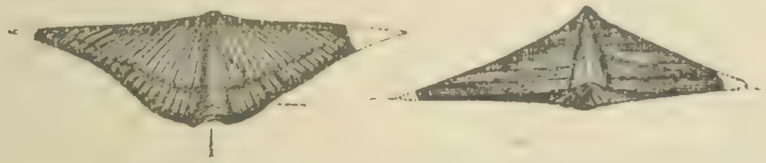
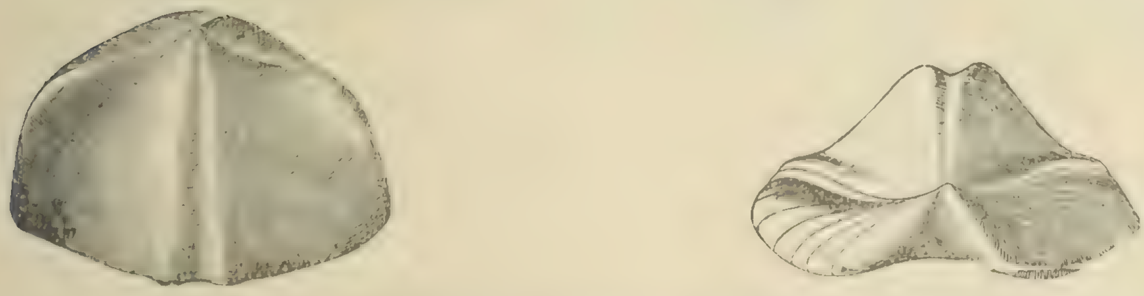


FIG. 21.— *Orthis biloba.*

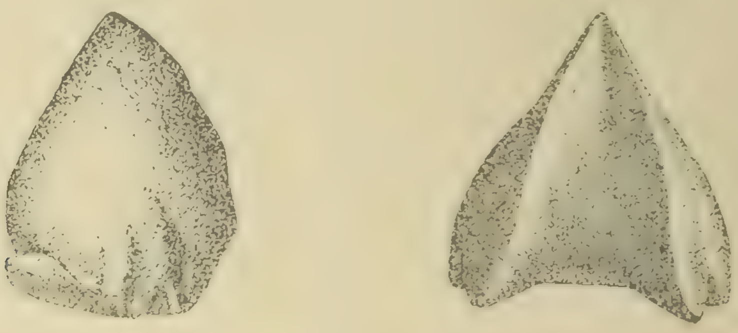


FIGS. 22 and 23.— *Spirifer angustus.*



FIGS. 24 and 25.— *Pentagonia unisulcata.*

the brachial valve may be compared to an operculum closing it; and in this fact is probably one efficient reason for the differences of size in the two valves.



FIGS. 26 and 27.— *Rhynchonella acuminata.* (DAVIDSON.)

In DISCINISCA the pedicle is a short plug extending at right angles to the horizontal plane of the valve; and here the lower or pedicle-valve is flat and the upper conical, while in ACROTRETA and CONOTRETA, where the pedicle was probably longer and more flexible, the lower or attached valve is highly conical and the upper nearly flat. As a general rule shells closely attached by a pedicle at this high angle to the plane of the brachial valve have a tendency to circular or subequal peripheral growth (DISCINA, DISCINISCA, ORBICULOIDEA, etc.), and a similar tendency is manifested in shells attached by solid cementation, not only in CRANIA, CRANIELLA, etc., which are hingeless genera, but also such genera as are provided with a hinge, when attached, evince a spreading or ostrean form of growth. Articulate shells, where the pedicle has maintained its function during a considerable portion of the period of adolescence (some species of SPIRIFER, CYRTINA, ATHYRIS, STROPHOMENA, LEPTÆNA, etc.), but later becomes atrophied, so that the animal must have dropped from its support and fallen upon the sea-bottom, are found to combine an elongate form with considerable breadth of hinge, and often with a highly developed cardinal area. In the Oriskany sandstone of Cumberland, Maryland, has been found a fragment of a valve of

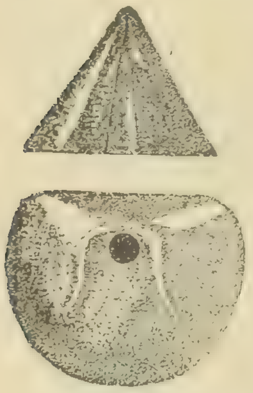


FIG. 28.—*Acrotreta gemma.* The pedicle-valve viewed from the posterior slope and from the apex.—(WALCOTT.)

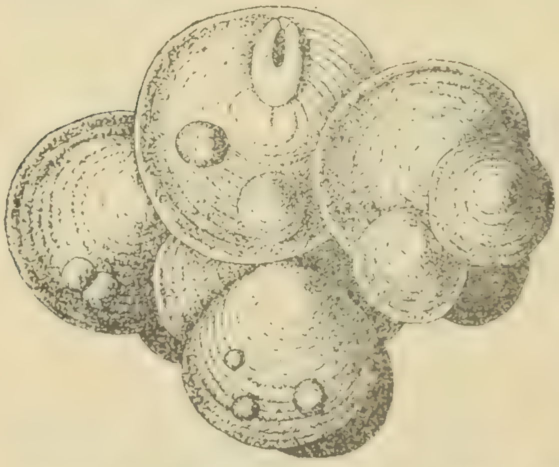


FIG. 29.—A cluster of young and old shells of *Disinisca lamellosa* (SOWERBY).

Spirifer arenosus, to which are attached a number of the young of *Cyrtina rostrata*, in their original position. The specimen shows that attachment by the pedicle in spiriferoid shells brought the cardinal area close and flat against the surface of adherence, the pedicle evidently having been extremely short. In such close attachment, obstructing, from the first, additions to to the posterior margin of the shell, may be suggested an explanation of the origin of the cardinal area and extended hinge.

In concavo-convex species, as of STROPHEODONTA, PRODUCTUS, PLECTAMBONITES, etc., the pedicle was evidently atrophied very early in the history of the individual. Some such shells, as RAFINESQUINA and LEPTÆNA, at times retain at maturity, a slight external evidence of a foramen, or the foraminal passage may even remain open as a minute puncture, but in this condition no sufficient number of muscular fibres could have passed through it to have supported the shell. Such shells, in becoming freed from the surface to which they were attached, would fall upon the sea-bottom, the heavier or pedicle-valve down, so that virtually this still acted as the attached valve. It will readily be understood that the contour of these concavo-convex shells is a necessary result of an obstruction to the marginal growth of the brachial or concave valve, by the more rapid growth of the pedicle-valve.

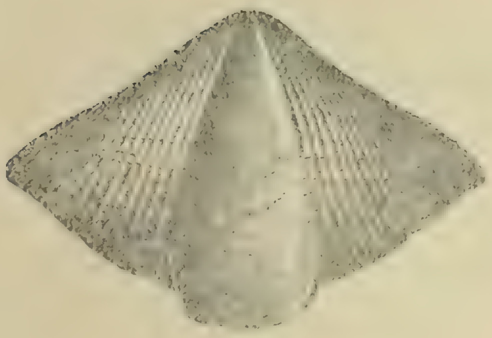


FIG. 30.—*Spirifer asper.*

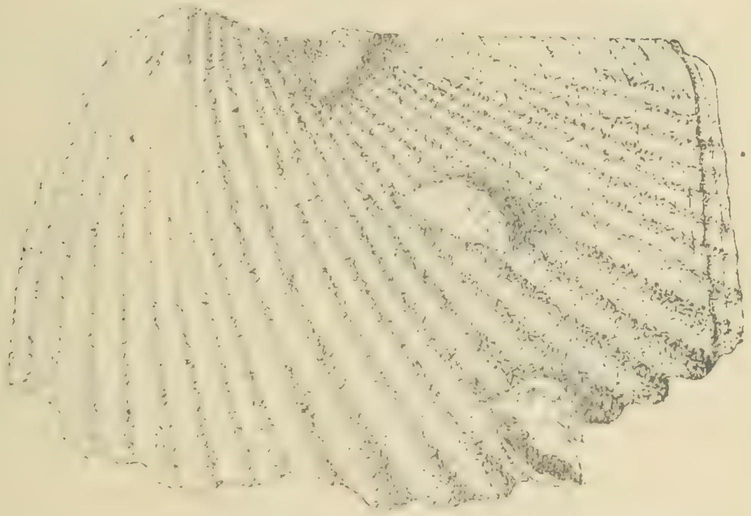


FIG. 31.—Young of *Cyrtina rostrata* attached by the face of the cardinal area to the surface of *Spirifer arenosus*. Oriskany sandstone, Cumberland, Md.

In many of these shells the pedicle-valve was provided with spines serving to attach it more firmly to its place in the sediment, so that it became less liable to be washed from its position; and among such spiniferous shells we find the greatest convexity of this valve, and often a remarkable extension of its anterior margins (PRODUCTUS). In *Productus* (*Proboscidella*) *proboscideus* and *P. Nystianus*, this modification is carried to an extreme, the pedicle-valve being greatly produced at its free margins which meet on the lower side and form a long tube, while the brachial valve is small, unmodified and operculiform. It has been suggested that the function of this modification is to transmit water to the animal deeply buried in the sediments.

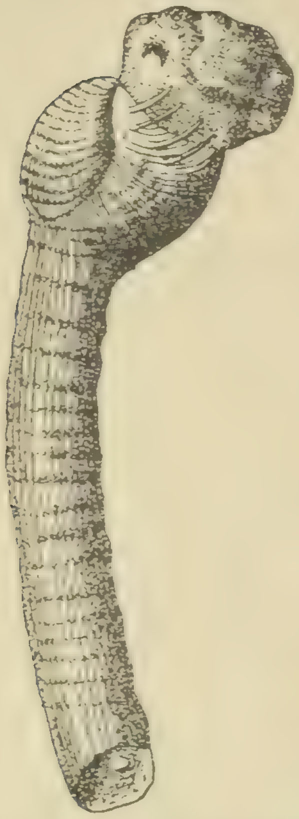


FIG. 32.—*Proboscidella proboscideus* (ETHERIDGE).

An opposite extreme of form occurs in certain nearly plane species of STROPHEODONTA (LEPTOSTROPHIA: plate 15, figs. 1-4), in which the two valves have maintained an equable growth for their entire extent.

There are a few shells of this concavo-convex group, whose valves have a double curvature. Thus in STROPHOMENA, STROPHONELLA and CHONOSTROPHIA, the contour of the two valves in youth, or in the umbonal region of adult shells, is normal, the pedicle-valve being convex, the brachial concave; but in later growth this contour becomes reversed, and the general concavity of the shell is on the pedicle-valve and its convexity on the brachial valve. The causes of such reversion in contour can only be due to an accelerated growth of the brachial valve after the early stages have been passed; and it may be observed that species of STROPHONELLA are all, virtually, reversed Stropheodontas. STROPHEODONTA is a genus which in its adult state, at successive periods in its history, exhibits in a most remarkable manner various phyletic developmental phases. Thus its earlier (Silurian) representatives

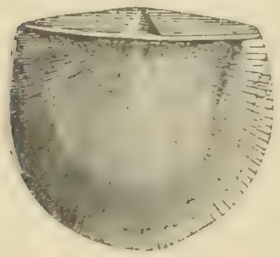


FIG. 33.—*Strophomena deltoidea.*

FIG. 34. — *Strophomena Wisconsinensis.* Profile view showing the convexity of the brachial valve and the concavity of the pedicle-valve in the umbonal region.

(BRACHYPRION) have the delthyrium either open or partially closed by a convex deltidium, and the crenulations of the hinge-line restricted to the immediate vicinity of the delthyrium. Gradual progress in these features is observable throughout the late Silurian and early Devonian species; and in the middle or later Devonian when the genus disappears, the species have the delthyrium completely closed, the outlines of the deltidium obliterated and the crenulation of the hinge extending to the cardinal extremities. There is corresponding progress in the development of the internal features. With each phase of STROPHEODONTA there is, in the same fauna, a corresponding phase of the reversed shell STROPHONELLA. In a certain sense the genera RAFINESQUINA and STROPHOMENA bear a similar relation to each other, both appearing and disappearing in geological history at about the same time.

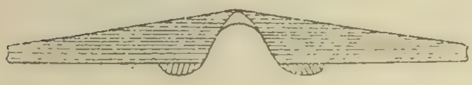


FIG. 35.—The cardinal area of *Stropheodonta (Brachyprion) Leda*; showing the few crenulations on the cardinal margin near the delthyrium. Clinton group. (BILLINGS.)

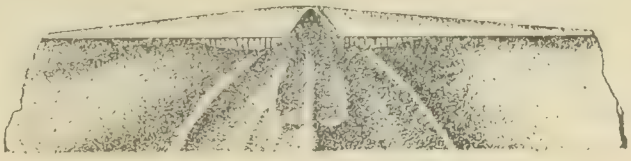


FIG. 36.—The cardinal area of *Stropheodonta (Brachyprion) profunda*, with more numerous cardinal crenulations. Niagara group.

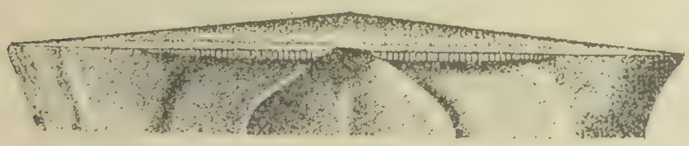


FIG. 37.—The hinge area of *Strophonella ampla*; showing the extension of the cardinal denticulations for about one-half the length of the hinge-margin.

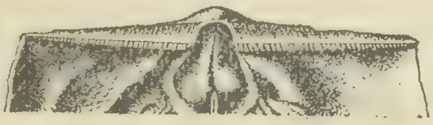


FIG. 38.—The cardinal area of *Stropheodonta demissa*, with the crenulations extending to the extremities of the hinge.

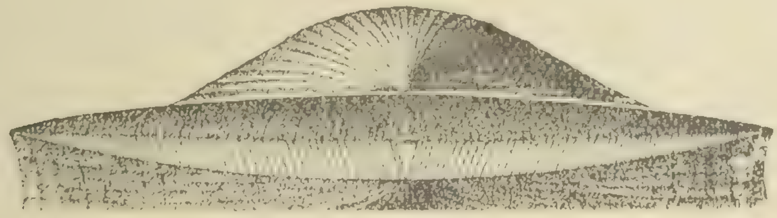


FIG 39.—The cardinal areas of *Stropheodonta demissa*; showing the closed delthyrium.

Ornamentation of the External Surface.

The surface of the brachiopod shell is rarely entirely smooth. It may bear only the concentric lines or varices of growth, and sometimes squamous, lamellar expansions, but as a general rule, the surface is covered with radiating striae, lines, plications or ribs, which may either be of equal size, may alternate in size, or be arranged in fascicles. Such configuration is of secondary growth, the incipient shell being free from it, except in rare instances where evincing an acceleration of development in this respect, or in other words, an earlier inheritance of specific characters. In the plicated shells, the plications of one valve generally alternate in position with those of the other, so that on the margins, the edges of the two series are interlocked, effecting complete closure.

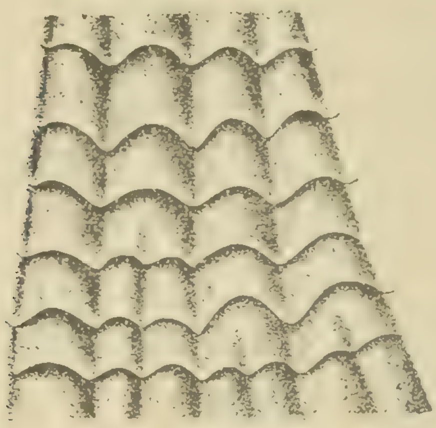


FIG. 40.—The lamellose surface of *Atrypa aspera*.

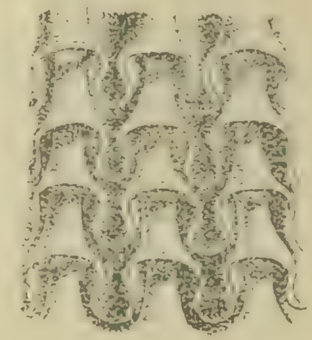


FIG. 41.—The concentric lamellæ of *Atrypa imbricata*; enlarged. (DAVIDSON.)

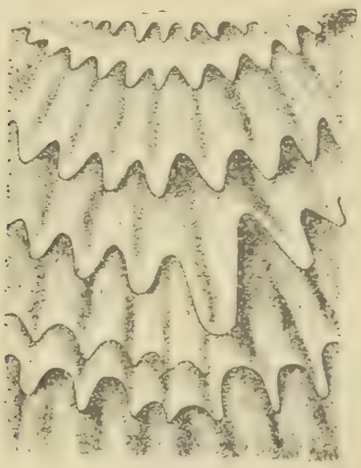


FIG. 42.—A portion of the exterior of *Atrypa reticularis*; showing the extension of the lamellæ and their tendency to fold upward into hollow spines.

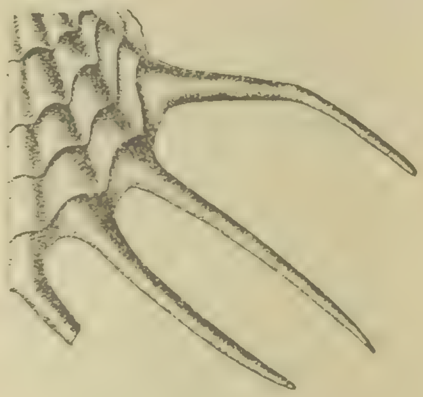


FIG. 43.—The surface spines of *Atrypa hystrix*.

The concentric lines when not wholly superficial may be regarded as representing periodic interruptions in the outward expansion of the mantle. In some genera, as ORBICULOIDEA, DISCINISCA, TRIMERELLA, etc., there are frequent irregular lamellose expansions of the outer shell layer, which produce a rough, squamous exterior (Plates 5, 6.). In species of ATHYRIS, ATRYPA, and, rarely, PRODUCTUS, there are regular expansions at the concentric lines, which are sometimes extravagantly extended (*Athyris concentrica*, *A. planosulcata*, *A. lamellosa*, *Atrypa reticularis*, etc.); in other species the concentric lamellæ become divided into a fringe of flat, hollow spines. Again, in SIPHONOTRETA, ATHYRIS, and SPIRIFER, there are rows of hollow, round spines, which are sometimes divided by a median partition (*A. hirsuta*) and may be compound, with pinnate lateral branches. (*S. fimbriatus.*) (See Plate 25, fig. 12). When the spines are irregularly scattered over the surface they are are generally of larger size. This is preeminently the case in PRODUCTUS, where the spines are often of great size and remarkable length. Such spines could never have been flexible, but they were frequently a means of attachment to foreign bodies, whether by cementation as in STROPHALOSIA, or by anchoring in the sediment.* In the younger conditions of such spiniferous shells the spines have, to some extent, opened into the inner cavity of the shell, but in later growth they became, for the

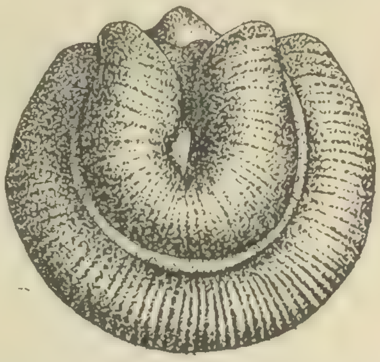


FIG. 44.—*Productus tesselatus*, viewed from the brachial valve; showing the curved fringes. (DAVIDSON.)

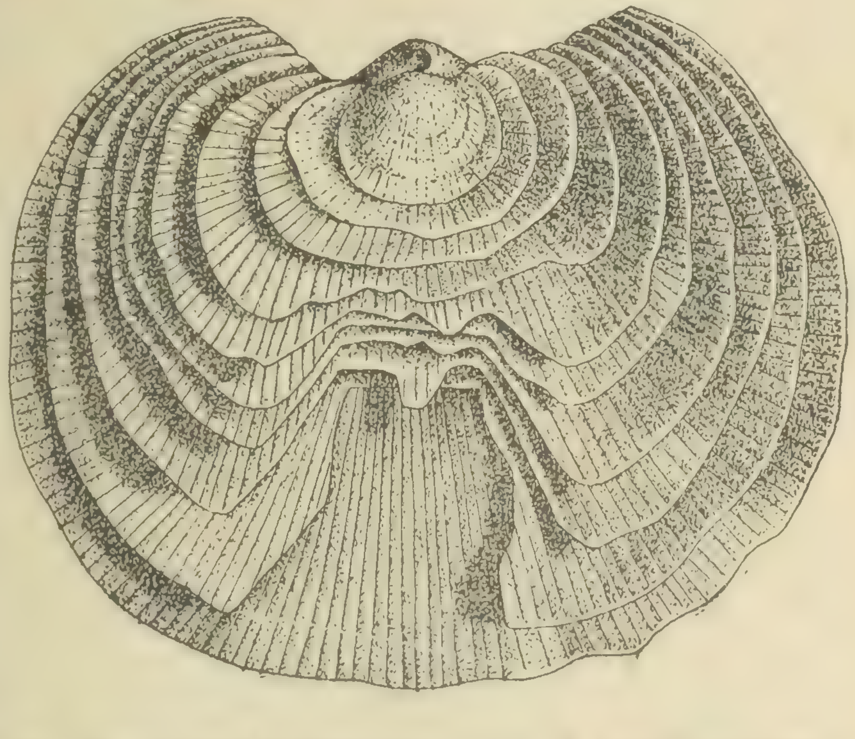


FIG. 45.—*Athyris planosulcata*, with its marginal expansions. (DAVIDSON,)

most part, closed. This statement, however, is not true of Chonetes where there is a single row of short marginal spines on the cardinal margin of the pedicle-valve alone; these cross the cardinal substance of the valve, have wide, internal openings and are believed to be closed at their outer extremities. In Anoplia these tubular passages exist, but are not extended into spines (see Plate 20, figs. 15-19). Some species of Siphonotreta and Strophalosia have the spines corrugated. In a few genera the cuticular or outer layer of the shell bears a reticulated or tesselated ornament, or series of coarse punctures arranged in quincunx (Trematis, Eichwaldia, Porambonites), or in radial rows (Orthis, Porambonites; Plate 6). The surface is often granulose, especially in species which possess a punctated shell, and sometimes in other shells, as Spirifer. The genus Leptæna is characterized by coarse concentric wrinkles or undulations over the horizontal or visceral area of the valves; rarely there are two series of fine oblique concentric wrinkles, as in Chonopectus. It has been observed that the greatest modifications of the exterior occur on the pedicle valve, and this difference may be largely explained by comparing the brachiopod with the bryozoan. If the brachial or upper valve of the former corresponds to the operculum of the latter, it is then the pedicle-valve which, as above suggested, may be regarded as the cell or main receptacle

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* It has been stated by YOUNG that in some species of PRODUCTUS the large spines appear to be furnished on the interior with a multitude of spinules standing convergent to the axis of the spine. This observation has not yet been verified by others.

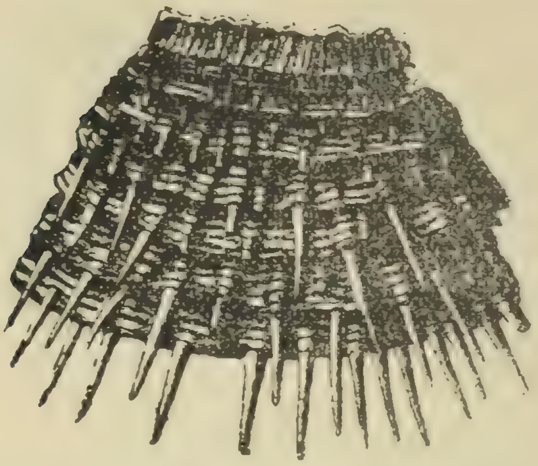


Fig. 46.—Portion of the shell of *Siphonotreta*; enlarged. (Kutorga.)

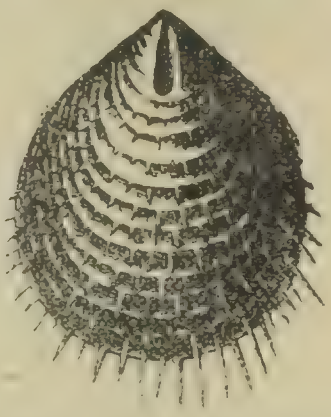


Fig. 47. — *Schizambon fissus.* (Kutorga.)

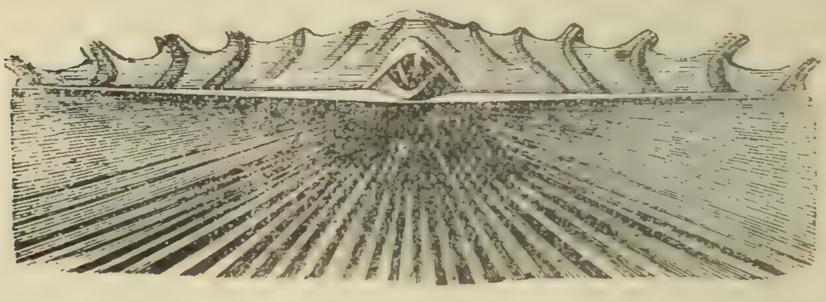


Fig. 48.—*Chonetes scitula.* Showing the tubes connecting the hollow marginal spines with the interior of the shell; enlarged.

of the animal, and is therefore more highly specialized and more susceptible to variation in its external form.

Cardinal area.— In many of the dentiferous or articulate brachiopods a conspicuous feature of the shell is the specialization of the posterior portion of the pedicle valve as a vertical or curved triangular area. The same character is sometimes present on the brachial valve, though less highly developed. In genera, which have a straight or extended hinge-line, this area attains its most conspicuous development. It does not bear the ornamentation of the rest of the external surface, but is smooth, or with horizontal lines of growth crossed by vertical lines of structure.

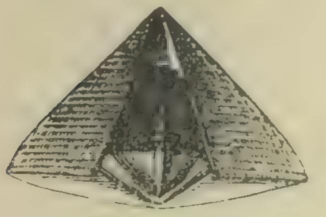
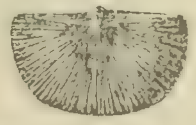


FIG 49. — Cardinal area of *Scenidium insigne*; enlarged.



FIGS. 50 and 51.—*Orthothetes arctostriata*; showing cardinal area and deltidium.

It has already been suggested that this area probably originated from the close attachment of the animal by its pedicle, which obstructed the outward growth of the valves. The intimate structure of this portion of the shell does not, however, differ materially from that of the remainder. In forms which were evidently suspended freely throughout their later existence, by a moderately long arm, this area does not exist (TEREBRATULA, RHYNCHONELLA, etc.), and this may be due to the fact that the posterior growth of the valves was unobstructed by close adhe-

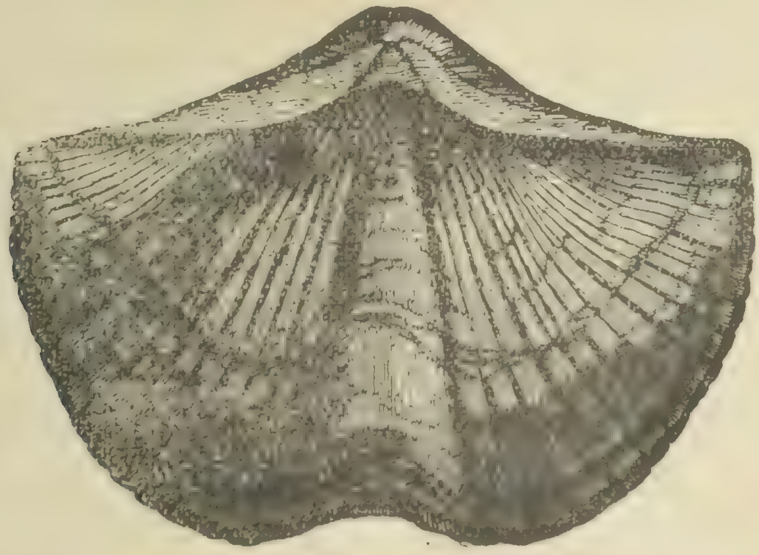


FIG. 52.— *Spirifer granulosus*; showing the cardinal area.

sion to the object of support. Among the edentulous genera there is rarely the least indication of such an area. In Acrotreta, Conotreta, Acrothele, Iphidea, etc., where the foramen is apical there is a posterior flattening of the pedicle-valve, upon which the concentric ornamentation of the shell is retained. This has sometimes been inaccurately termed a "false cardinal area," or a "pseudo-area." Though not so sharply defined as the cardinal area in the articulate brachiopods, it is nevertheless an homologous structure and needs no other designation. In such genera as Discinisca, Orbiculoidea, etc., there was no obstruction to the posterior growth of the shell, and therefore no cardinal area.

The Delthyrium and its Coverings.

By the term *delthyrium* is meant the median triangular fissure or cleft which crosses the cardinal area of the pedicle valve; or when that area does not exist, traverses the posterior surface from apex to cardinal line. It is the passage for the pedicle, and always subserves this function when existing in an uncovered condition in adolescent or mature growth. In Orthis this is its normal condition at maturity; but it has been shown that the open delthyrium at this stage, in *Orthis varica*, is actually a modified phase, the shell having assumed in youthful growth a convex covering or deltidium, which is subsequently resorbed. In Schizocrania the triangular slit is retained in all stages of growth, and in Trematis its outer edges converge at maturity, while in Orbiculoidea it is altogether a feature of early growth, the adult shell having the passage closed by the union of the edges on the posterior margin, and the contemporaneous formation of a transverse plate or *listrium* beneath the apex. In the inarticulate genera Iphidea and Vol-

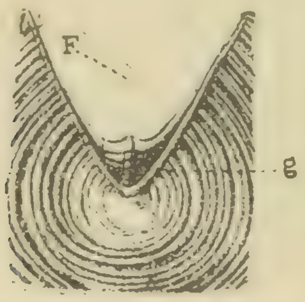


FIG 53.—Pedicle passage of *Schizocrania filosa*. *F*, triangular pedicle fissure; *g*, listrum.

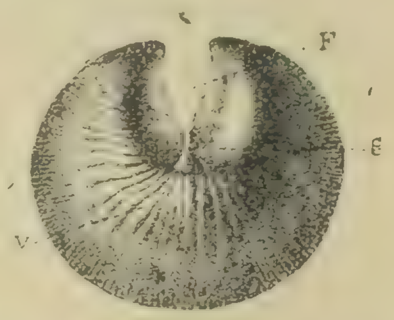


FIG 54.—*Trematis treminalis.* Interior of pedicle-valve. *F*, foramen; *v*, vascular sinuses; *g*, pedicle-groove.

BORTHIA the place of the delthyrium is covered by a convex ridge; in ACROTRETA and CONOTRETA there is a groove instead of a ridge.

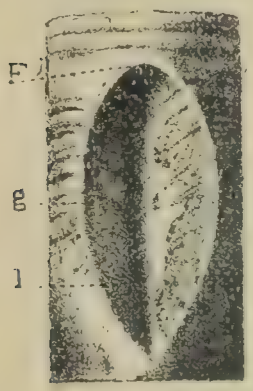


FIG. 55.—Pedicle-groove of *Orbiculoidea tenuilamellata.* *F*, foramen; *g*, base of groove; *l*, walls of groove.

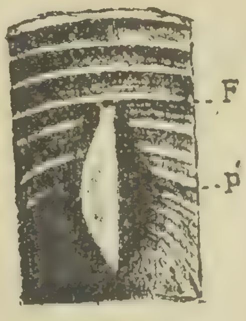


FIG. 56.— Pedicle-area of *Orbiculoidea Herzeri* viewed from within. *F*, foramen; *p′*, under surface of listrium.

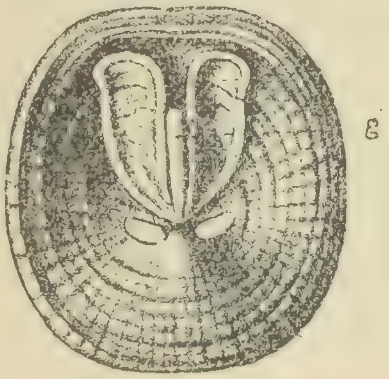


FIG. 57.—Interior of pedicle-valve of *Orbiculoidea nitida.* *F.* foramen; *g′*, inner surface of pedicle-groove or listrium. (DAVIDSON.)

The convex ridge or plate which has been termed the *deltidium* in the articulate brachiopods is retained in many genera at maturity (PROTORTHIS, BILLINGSELLA, STROPHEODONTA, STROPHOMENA, LEPTÆNA, ORTHOTHETES, DERBYA, etc., etc., Plates 8, 13, 19) and it usually exists in all species which have the cardinal area developed. That it is not always retained may be due to different causes. Its union with the margins of the delthyrium are lines of weakness along which it is often readily separated from the valves; it may be gradually abraded or become resorbed by the animal.

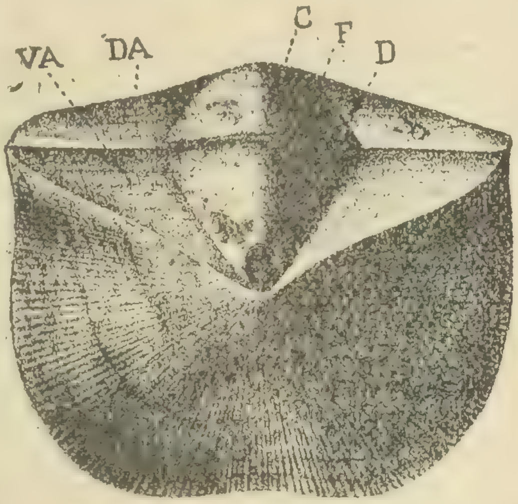


FIG. 58.—*Clitambonites (Orthisina) anomala.* VA, cardinal area of pedicle-valve; DA, cardinal area of brachial valve; D, deltidium; C, chilidium; F, foramen. (DEVERNEUIL.)

In some of the dentiferous genera in which the cardinal area is very obscurely defined and the umbo of the pedicle-valve closely incurved (PENTAMERUS, AMPHIGENIA), the deltidium is concave, and the pedicle probably not functional at maturity.

In most of the articulate genera, however, such as TEREBRATULA, RHYNCHONELLA and their allies, MERISTA, MERISTELLA, RETZIA, etc., etc. the covering of the delthyrium consists of two convex plates formed by gradual growth along the margins of the opening and uniting in the median line; bounding the lower side of, or encircling the pedicle. Various stages in the development of these

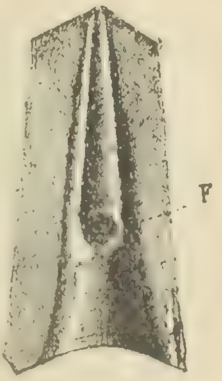
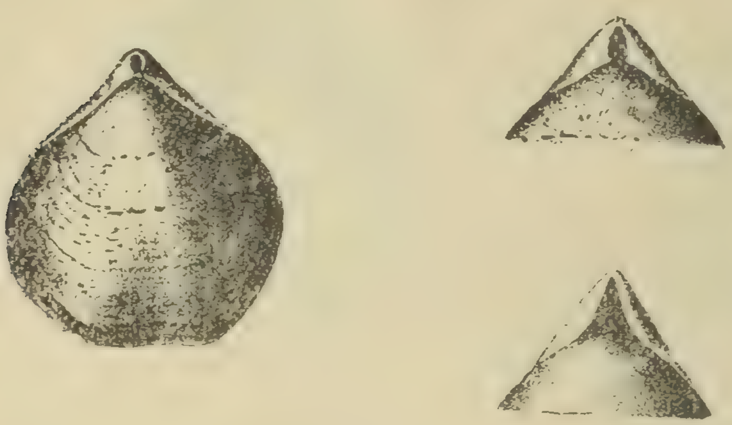


FIG. 59.—Deltidium of *Cyrtina* F, foramen. (DAVIDSON.)

deltidial plates are attained at the maturity of different species. (Plate 23, figs. 11 and 12.) Thus, in *Meristina rectirostris* they are but feebly, if at all developed, evincing either the embryonic or degenerate character of the adult in this respect; while in *Eumetria Verneuiliana* they are closely united by coalescence from the apical foramen to the hinge and their convexity wholly obliterated.


FIGS. 60, 61, 62.—*Whitfieldella nitida*; showing the progressive closing of the deltidium by the growth of the deltidial plates. The figures at the right represent immature conditions, that at the left the adult state.

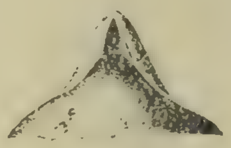


FIG. 63.—The adult condition of the delthyrium in *Meristina rectirostra*, showing the absence of deltidial plates.

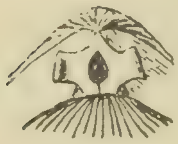


FIG. 64.—*Rhynchonella Grasiana*, showing the extravagant growth of the deltidial plates in the adult (DESLONGCHAMPS.)

With present evidence, these deltidial plates appear to be a secondary modification of the delthyrium, induced after the disappearance of the original covering of this passage from the causes already suggested.

In many of the articulate genera the delthyrium, if left open either from resorption of its normal coverings or from a failure to develop them, becomes filled by a progressive secretion of testaceous matter in the later stages of growth. This is especially marked among a certain group of the Spirifers where this callous growth forms a more or less complete transverse plate; and the extreme result of this development is exhibited by the genus SYRINGOTHYRIS, in which this condition of hypertrophy in the shell glands, produces not only a complete transverse plate covering or partial filling of the cavity extending from

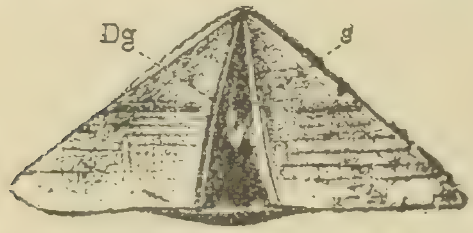


FIG. 65.—A cardinal view of *Spirifer asper*; showing the callosity in the delthyrium.

the apex nearly to the basal margin of the delthyrium, but also builds up on the inner side of this plate a tubular sheath, open along its ventral surface and which probably inclosed the atrophied pedicle of the animal. This peculiar tubular structure may be termed the *syrinx.*

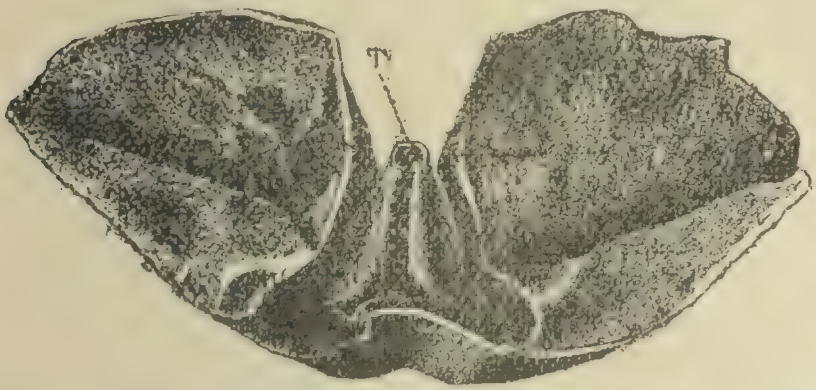


FIG. 66.—Interior of pedicle-valve of *Syringothyris.* T, the split tube or syrinx.

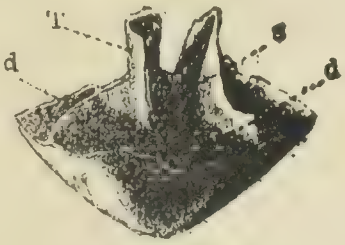


FIG 67.—*Syringothyris typa.* The interior of the umbonal portion of the pedicle-valve, showing the split-tube or syrinx attached to the transverse plate filling the delthyrium.

The covering of the delthyrium in the brachial valve (*chilidium*) which is always a single plate is of later growth than the deltidium, and is therefore not a primitive structure.

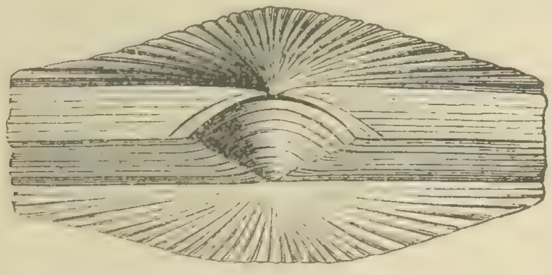


FIG. 68.—Cardinal view of a portion of the valves of *Orthothetes subplana* ; showing a remarkable development of the chilidium.

THE INTERNAL CONFIGURATION OF THE VALVES.

Articulating Apophyses.

Articulation of the valves is mainly effected by means of *teeth and sockets*, the former on the pedicle-valve, the latter on the brachial valve. In inarticulate genera the valves are usually held in apposition simply by muscular contraction, and seldom is any tendency to the formation of articulating processes manifested. Occasionally low bosses are formed on the cardinal margin of the pedicle-valve (TRIMERELLA, BARROISELLA, TOMASINA ; Plate 1, fig. 14), which probably subserved to a certain extent the purposes of a hinge. In the articulates the teeth lie at, or just beneath the cardinal margin, and at either side of the delthyrium. They are short processes, free at their extremities, which are frequently curved upward or backward into their sockets in the opposite valve, thus locking the valves in such a manner that it often becomes impossible to separate them without breaking the teeth. Both teeth and sockets vary considerably in their development in different genera, and in different species of the same genus, but they are invariably two in number and are always constructed on the same plan.

Articulation is also aided by the *cardinal process*, an apophysis situated at the center of the hinge of the brachial valve, and which in certain extinct genera, as STROPHEODONTA, DERBYA, NUCLEOSPIRA, PRODUCTUS, STRINGOCEPHALUS, is of a very considerable size. This process was a surface of attachment of certain muscles, which, by their contraction, opened the valves, and its size is due to the fact that testaceous matter has been rapidly secreted about the extremities of the muscular bands. It is in the later stages of growth that the cardinal process obtains notable size, and that usually in species where the pedicle has become atrophied and is no longer an obstacle to its growth. The posterior surface of this process, which was the surface of muscular attachment, is variously lobed, furrowed or striated. (Plates 9–22.)

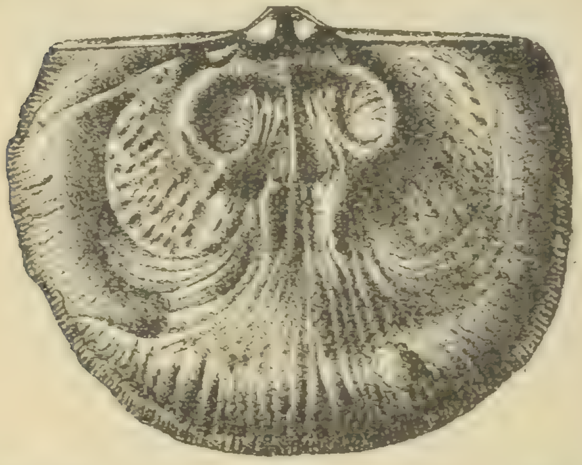


FIG. 69.—*Rafinesquina alternata.* Interior of the brachial valve.

The cardinal process is frequently connected with, and often merged into, an elevated central *hinge-plate.* This plate is not found in genera where the cardinal process attains its highest development (STROPHOMENA, DERBYA, ORTHOTHETES, TRIPLECIA; Plates 16, 17 and 18), but, rather in those whose brachia are provided with calcified supports (MERISTELLA, RETZIA, ATHYRIS, TEREBRATULA, etc.), and while it is in some degree a surface of muscular attachment, it also serves as a support to the bases of the brachia (*crura*).

The inner margin of the hinge in both valves frequently bears a series of fine, interlocking denticulations, making an arrangement which contributes to the firmer union of the valves (Stropheodonta, Spirifer, etc.). Interlocking plications about the lateral and anterior margins of the valves serve a similar end.

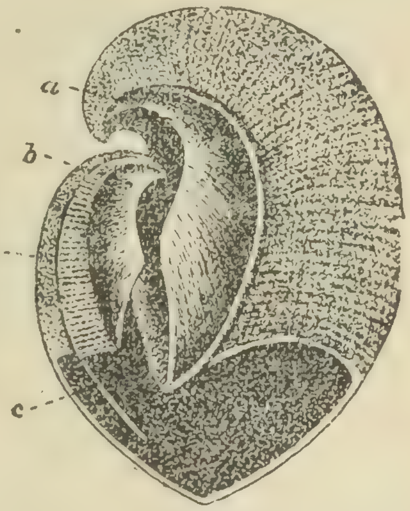


Fig. 70.—*Conchidium Knighti.* Longitudinal section, showing the septa (*s*) and spondylia (*a*, *b*) of both valves, and the crura (*c*). (Davidson.)

Septa.

Vertical plates or *septa* divide the interior cavity of the valves of some genera in various ways. The teeth are frequently supported by such plates, one on each side of the delthyrium of the pedicle valve, and these are known as *dental plates.* Such plates may rest upon the inner surface of the valves or converge and unite, forming a spoon-shaped process, or *spondylium,* which is sometimes free, except at its posterior margin, but is usually supported by a *median septum* (Clitambonites, Pentamerus, Camarophoria, etc.). When the spondylium is not present in the pedicle-valve, a median septum often divides the muscular region and itself becomes a surface of muscular attachment (Enteletes, Spiriferina). There may also be one or more *lateral septa* on each side of the median one, as in the genus Polytœchia (Plate 8, figs. 16–20); this, however is of rare occurrence.

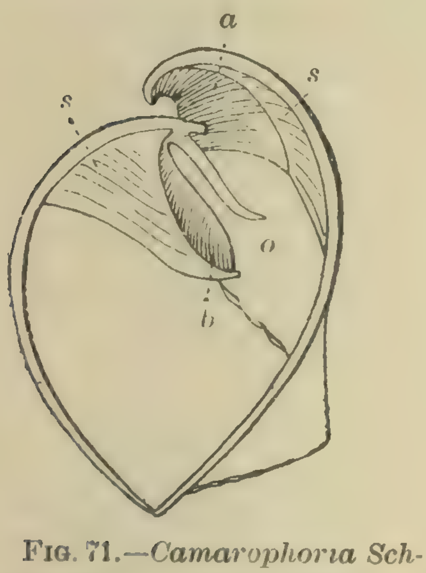


Fig. 71.—*Camarophoria Schlotheimi. s*, median septa; *o* crura; *a*, spondylium of pedicle-valve; *b*, spondylium of brachial valve. (Woodward)

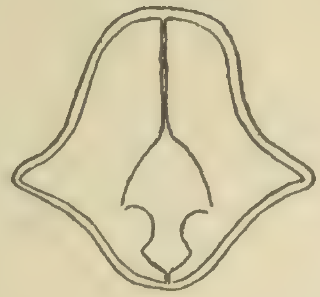


Fig. 72.—*Sieberella Sieberi.* Transverse section showing the spondylia supported by median septa.

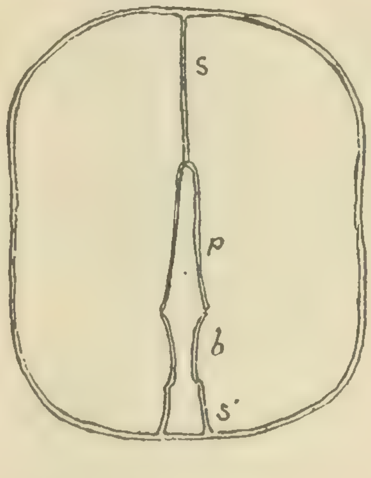


Fig. 73.—Transverse section of *Conchidium Knighti. s*, median septum of pedicle-valve; *s'*, septa of brachial valve; *p*, spondylium of pedicle-valve; *b*, crura, plates.

In the brachial valve the *crura* or bases of the brachial processes may be supported by divergent vertical septa, known as the *crural plates.* These may also converge and form a spondylium. Accompanying these, or independent of them, may be a prominent median septum (ENTELETES, KAYSERELLA, PENTAMERUS); and the latter may support the spondylium. There may also be two parallel median septa supporting the convergent, but not united crural plates (BARRANDELLA, PENTAMERUS, CONCHIDIUM). In the inarticulate genera the median and lateral septa are sometimes well developed, but do not often attain great size (LINGULA, DIGNOMIA, GLOTTIDIA, LINGULASMA, etc.).

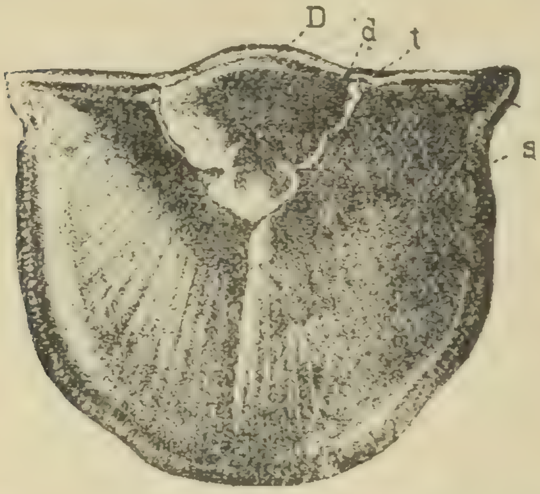


FIG. 74.—Interior of pedicle-valve, of *Orthisina anomala.* D, deltidium; *t*, teeth; *d*, dental plates, forming a spondylium; *s*, median septum. (DAVIDSON.)

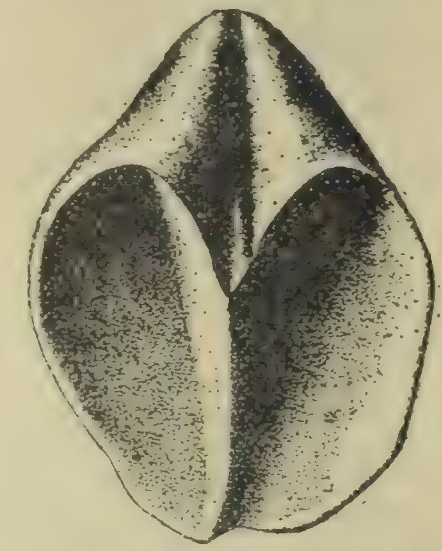


FIG. 75.—The interior of the pedicle-valve of *Conchidium;* showing the spondylium.

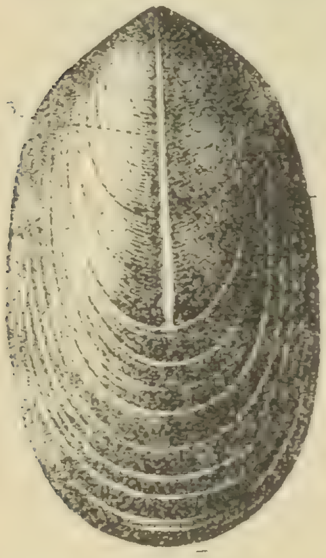


FIG. 76.—*Lingula Delia*, with median septum (*s*).

Muscular scars.

The impressions made upon the shell by the attachment of the muscles are usually confined to the umbonal and posterior portions of the valves. There are some exceptions to this rule, as in the case of *Hipparionyx proximus* and a few members of the orthoid genus RHIPIDOMELLA, where the great scars of the pedicle-valve extend almost to the anterior margin of the shell. The impressions of the several muscular bands are retained with various degrees of distinctness; among the fossils they are often merged with one another, so that only the outline the muscular area, as a whole, is visible. Among the articulate genera one plan of arrangement is maintained without essential modification. In the middle line of the pedicle-valve is a narrow oval impression of the *adductor muscle*, which is divided medially into two scars; at the sides are two pairs of scars, the larger in front (*diductors*), the smaller behind (*pedicle-muscles*).

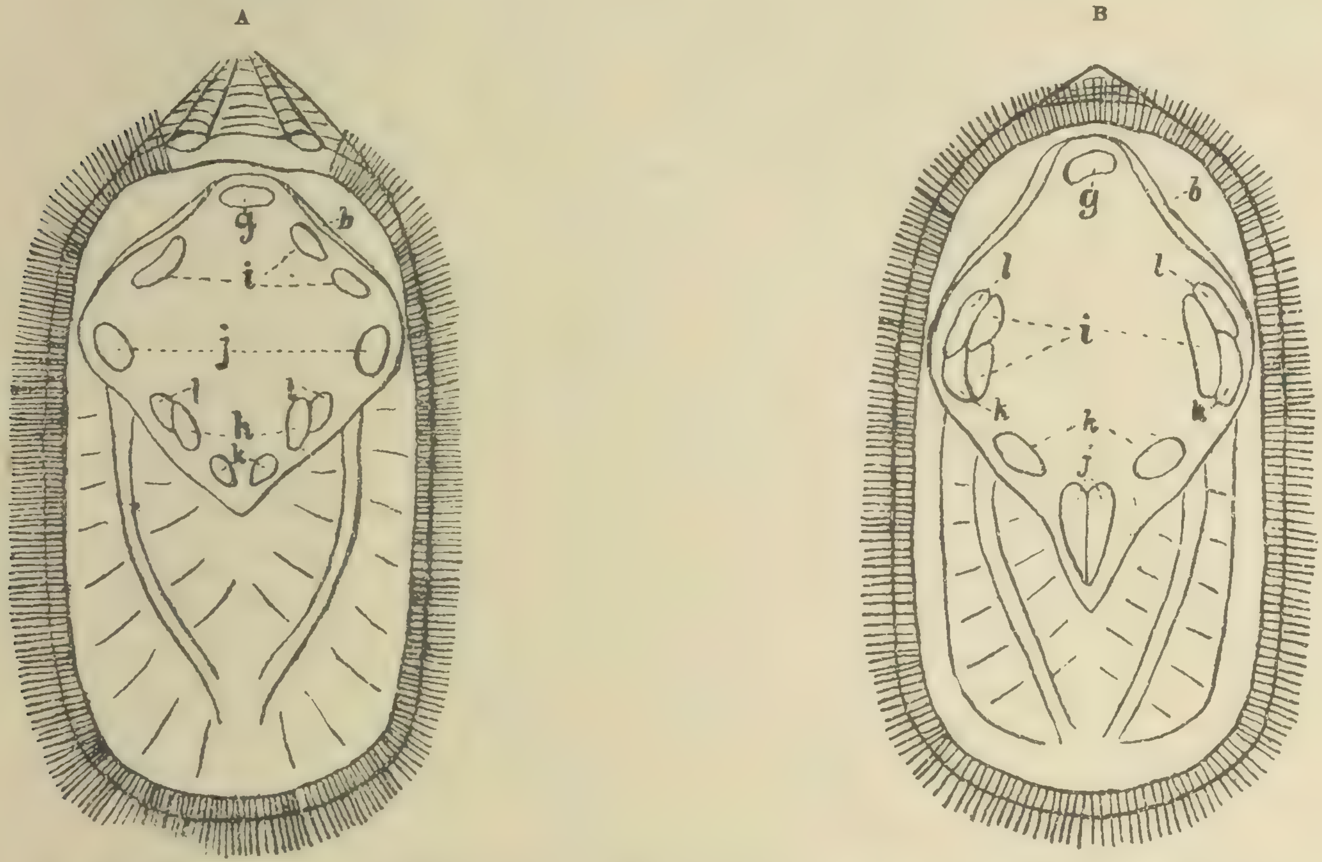


FIG. 77.—Muscular system of *Lingula anatina*: A, pedicle-valve; B, brachial valve; *b*, parietal scar; *g*, umbonal muscle; *i*, transmedians: *h*, centrals; *j*, *k*, *l*, laterals (*j*, anteriors: *k*, middles; *l*, externals). (DAVIDSON.)

Occasionally the scars of a small *accessory* pair of *diductors* are found just behind the adductor scars; and behind these is an

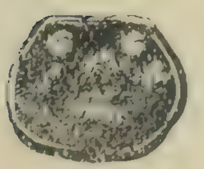
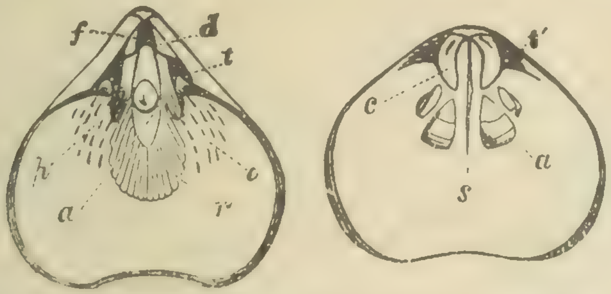


FIG.78.—*Craniella Hamiltoniæ.* The attached valve, showing the anterior and posteror adductor scars.



FIGS 79, 80.—Interiors of the pedicle and brachial valves of *Rhynchonella* (*Hemithyris*) *psittacea*; *f*, foramen; *d*, deltidial plates; *t*, teeth; *t′*, dental sockets; *p*, pedicle muscle; *a*, adductors; *r*, diductors; *o*, ovarian markings; *c*, crura; *s*, septum.

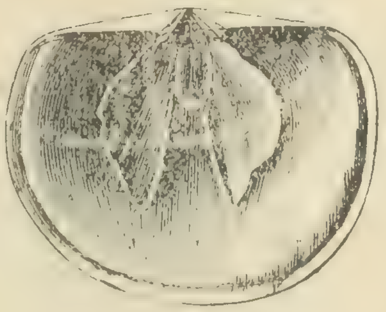


FIG. 81.—Interior of the pedicle valve of *Orthis Clytie*, showing the pedicle, adductor and diductor scars

undivided scar of the *pedicle-muscle*. In the brachial valve there are four undivided adductor scars in two distinct pairs, one the *anterior*, the other the *posterior* pair. This arrangement of the scars is very simple compared with that found in some of the inarticulate genera (LINGULA, DISCINISCA), but among the fossil species of such genera the muscular impressions are rarely retained with distinctness. For the fuller elucidation of this subject the student is referred to the chapter on the MUSCULAR SYSTEM.

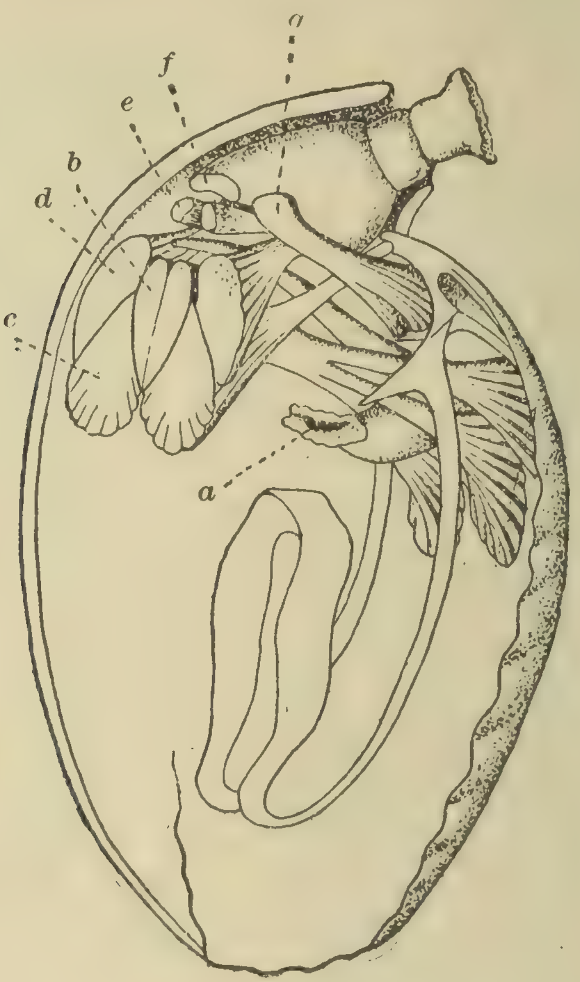


FIG. 82.—Muscular system of *Magellania australis.* *a*, mouth; *b*, adductors; *c*, diductors: *d*, ventral pedicle muscles; *e*, accessory diductors; *f*, median pedicle muscle; *g*, dorsal pedicle muscle. (WOODWARD.)

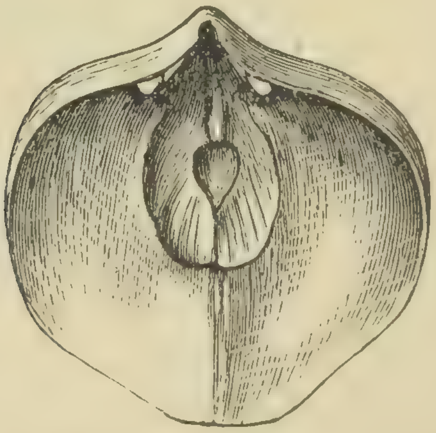


FIG. 83.—Interior of the pedicle-valve of *Athyris spiriferoides*; showing adductor and diductor scars.

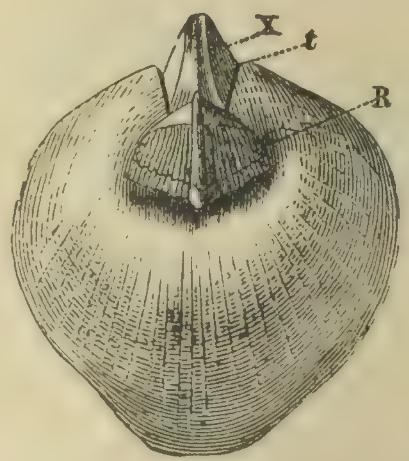


FIG. 84.—Internal cast of the pedicle-valve of *Meristella nasuta;* *X*, filling of rostral cavity; *t*, position of teeth

Pallial Sinuses and Genital Markings.

Traces of these features are frequently retained on the shell with more or less distinctness. The *pallial sinuses* are usually two convergent (LINGULA, OBOLUS) or divergent (STROPHOMENA, STROPHEODONTA, etc.) trunks, from the outer margins of which emanates a series of secondary ramifying branches. Among the inarticulates there may also be branches along the inner margin of these sinuses. In STROPHOMENA, STROPHEODONTA, etc., the inner margin of the main trunks bounds the genital area, which

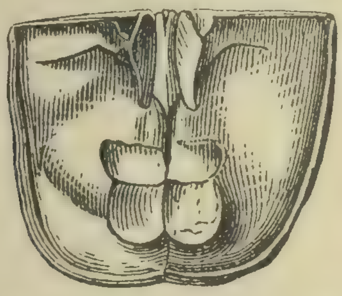


FIG. 85.— Interior of brachial valve of *Ambocoelia umbonata;* showing the four adductor scars

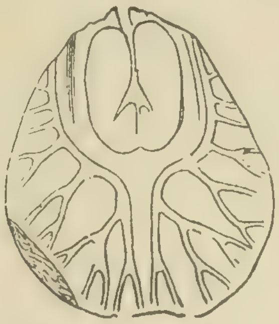


FIG. 86.—*Eatonia peculiaris.* The pallial sinuses on an internal cast of the pedicle-valve.

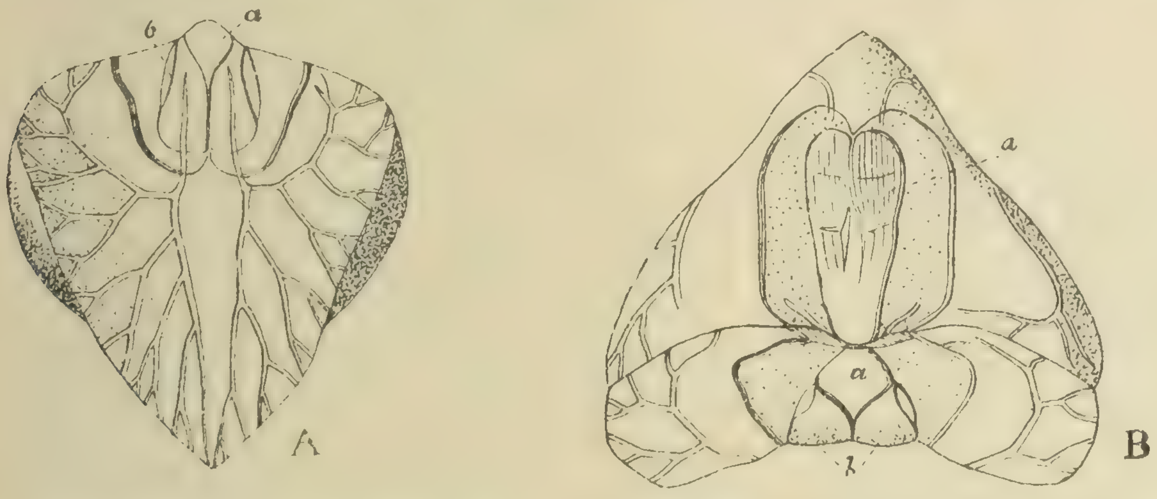


FIG 87.— *Rhynchonella acuminata,* showing the pallial sinuses on an internal cast. A pedicle valve; B, umbonal view; *a*, adductor scars; *b*, diductors. (WOODWARD)

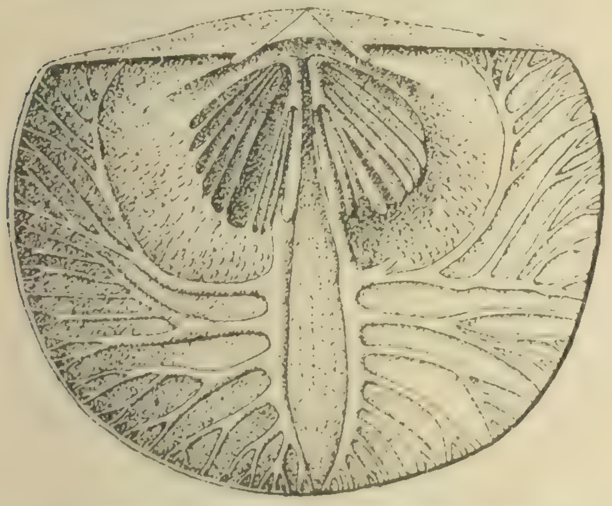


FIG. 88.—*Rafinesquina expansa.* Interior of pedicle-valve, showing pallial sinuses. (DAVIDSON.)

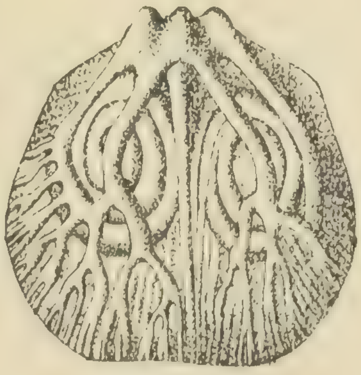


FIG. 89.—*Koninckina Leonhardi;* interior of brachial valve, showing pallial sinuses crossing the impressions of the spiral arms. (WOODWARD.)

usually has a pitted surface. In SCHIZOPHORIA there are four or more subparallel longitudinal main pallial sinuses which subdivide toward their distal extremities. (Plate 11, figs. 21–23.)

Further reference will be made to the structure of the sinuses and genital organs.

Structure of the Test.

The valves of the Brachiopoda are composed of successive laminæ of heterogeneous structure. These may be wholly calcareous, and not more than two or three in number, or alternately calcareous and corneous, and not restricted to any numerical limit. Shells largely corneous or chitinous in their composition are restricted to the inarticulate division, but the inarticulates do not all possess corneous shells. In the living LINGULA there is an alternation of corneous and calcareous layers varying in thickness, the former being compact and imperforate, the latter fibrous or prismatic and crossed by a great number of minute tubules. In fossils of this group the calcareous matter is frequently more or less removed, so that shells in this condition may appear to be essentially corneous in their composition. In the group of fossil linguloids, beginning with LINGULA, passing through LINGULOPS and LINGULASMA to TRIMERELLA and its allies, there is a regular increase in the relative amount of calcareous matter in the shell, so that the Trimerellas, which are large and ponderous shells, seem to have wholly lost their corneous matter. In CRANIA also, the shell is essentially calcareous and the successive layers are punctured by tubules or vertical canals, which are largest at their openings on the interior of the valves, and narrow toward the outer surface. These never pierce the thin outer or epidermal layer of the shell.

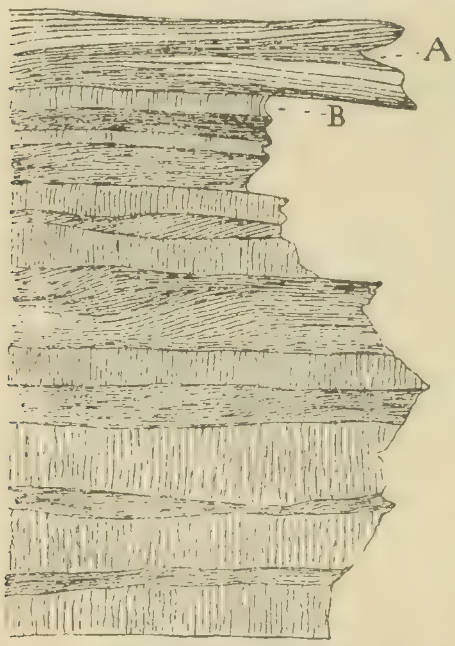


FIG. 90.—Magnified section of the thickest portion of the shell of *Lingula anatina*. *a*, corneous layers; *b*, mineral layers with vertical canals. (GRATIOLET.)

Among the articulate genera, under favorable preservation, there may be distinguished three distinct calcareous shell layers; an inner prismatic or fibrous layer, which constitutes the greater portion of the shell; above this is a thin lamellar layer, and the outer surface of the shell is covered by a tenuous epidermal film or *periostracum.* When the shell is punctate, as is frequently the case (the orthoids, Cyrtina, Spiriferina, the productoids, terebratuloids) the tubules open on the inner surface in narrow apertures, whence they widen upwards, abruptly expanding in the lamellar layer, at whose upper margin they terminate. They do not pierce the *periostracum*, and it has not been demonstrated that any brachiopod shell is completely traversed by them. Certain species of Orthis (Rhipidomella) have been shown by Young to possess epithelial punctures which were probably the points of insertion of short spinules; these coexist with fine tubules which perforate the inner layers. The coarser spines occurring in such genera as Siphonotreta and Productus are hollow, and may sometimes penetrate the entire substance of the shell. The perforations vary greatly in size and number. In the terebratuloids

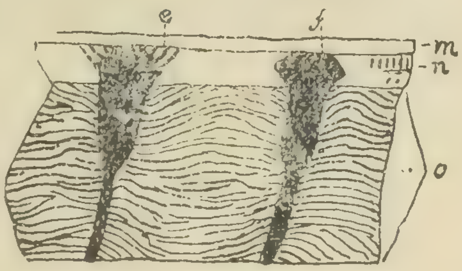


Fig. 91.—Shell structure of a punctate articulate branchiopod. *o*, prismatic layer; *m*, outer, imperforate layer; *n*, intermediate, laminar layer; *f*, broad extremity of perforation; *e*, radiating grooves about extremity.—(King.)

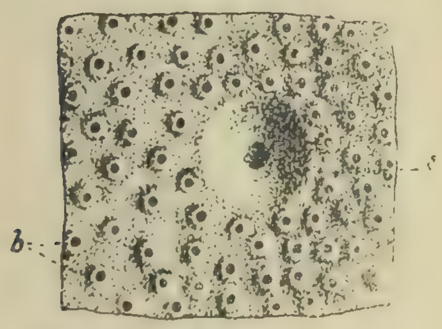


Fig. 92.—Inner surface of a valve of *Productus semireticulatus*, showing the opening of a spine (*s*) and the elevated terminations of the punctæ (*b*). (Davidson.)

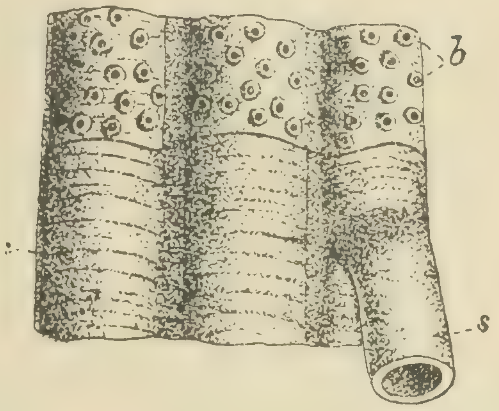


Fig. 93.—Portion of outer surface of *Productus longispinus*. *s*, spine; *c*, imperforate outer layer; *b*, punctæ of inner layer. (Davidson.)

they are frequently visible to the unaided eye; in SYRINGOTHYRIS they are often difficult of discernment, and among fossils generally have probably been to some degree obscured by the process of fossilization. In smooth shells they are usually equally disseminated, but in plicated species they are arranged in rows on the plications or in the furrows. They may traverse the shell vertically, but their tendency is usually obliquely forward in the direction of shell-growth, and in some instances (*Tropidoleptus carinatus*) they converge toward the plications. Such variations in arrangement may leave certain portions of the shell impunctate while other portions are richly supplied with tubules.

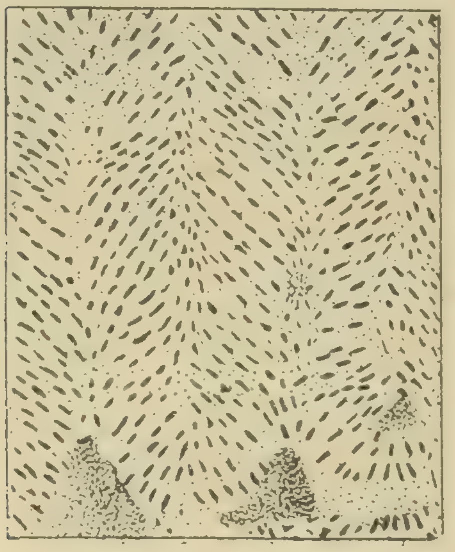


FIG. 94.—An enlargement of the shell structure in *Tropidoleptus;* showing the convergent tubules.

The full taxonomic significance of these test-perforations and their function, is not as yet understood. In certain groups of shells some of the members may be punctate, others impunctate. Thus among the orthids we find that the earlier and typical members (*O. callactis*, etc.), are completely impunctate; so also are PLATYSTROPHIA, HEBERTELLA and DINORTHIS; while the greater number of species belonging to the group, especially its later (Upper Silurian, Devonian and Carboniferous) members, are richly punctate. The shell of SPIRIFER, again, is normally impunctate, while the closely related genera CYRTINA, SPIRIFERINA and SYRINGOTHYRIS are punctate, and even a few species which must still be referred to the genus SPIRIFER have a sparsely punctated shell (*S. plenus*). RHYNCHONELLA and its recent and fossil allies are impunctate, except RHYNCHORA and RHYCHOPORA, which are simply rhynchonellids with punctate shell.

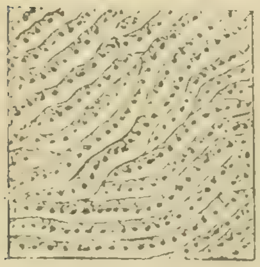


FIG. 95.—An enlargement of an exfoliated surface of *Spirifer plenus;* showing the shell punctations.

There are certain conditions which appear to have induced the deposition of impunctate shell-matter even in species uniformly perforated. JOUBIN has shown that the deposits about the edges and base of the muscular bundles is without perforations. The same is true of all adventitious deposits in punctate shells; senile enlargements of the teeth and cardinal process, the callosities in the delthyrium, as in **SPIRIFER**, and the syrinx in **SYRINGOTHYRIS**. Whether the teeth and other articulating apophyses are impunctate in their earlier condition, has not been determined. The calcareous secretions in the brachia (spirals, loops, etc.,) are also impunctate.

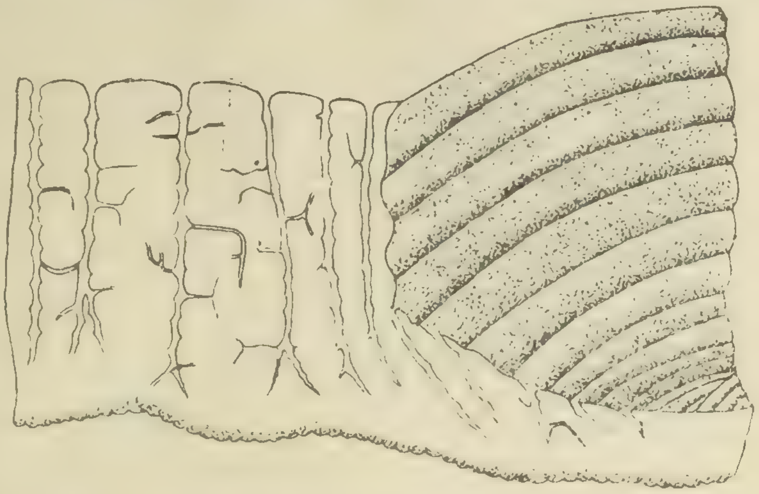


FIG. 96.—Vertical section of an attached valve of CRANIA, showing the normally perforate shell, and the imperforate deposit beneath the muscular scar (JOUBIN).

As to the function of the punctæ, it is quite generally believed that they are connected with the respiration of the animal. In recent punctate species the tubules are filled by diverticula from the mantle, which are readily seen by dissolving the shell of a terebratuloid in dilute acid. The fact, however, that they are not exposed to the water at their extremities may interfere with this interpretation, unless an increased exposure be effected by the access of water from within the body chamber. It has been observed by MORSE that the punctæ in **TEREBRATULINA** appear only after the shell has passed its earliest growth-stages.

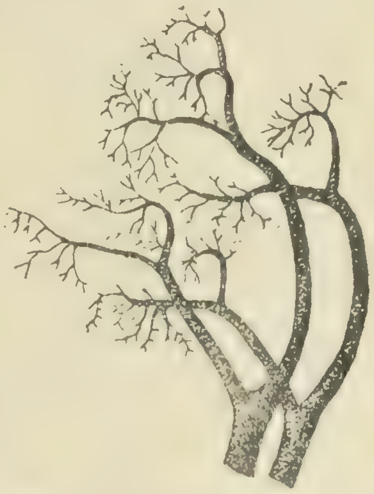


FIG. 97.—Extremities of the shell perforations in CRANIA.—(JOUBIN).

THE ANIMAL.

General Characters.

Upon opening the valves of a living brachiopod, the body, or that part of it which contains the essential organs, is found to be restricted to the posterior part of the internal cavity, while the anterior one-half or two-thirds of this space is filled by the coiled arms from which the name of the class is derived. The degree to which the valves can be voluntarily opened by the animal is very restricted, only sufficient to freely admit water currents to the brachia (TEREBRATULINIA, MAGELLANIA, etc.), or to extend the brachia when they are protrusible, as in HEMITHYRIS, etc. In *Lacazella mediterranea* the brachial valve in opening may traverse an arc of 90°, but no other species is known to possess this capacity. The *viscera* are separated from the cavity of the brachia by a vertical membranous wall, which is an extension of the *pallium* or *mantle.* The *shell-cavity* is, therefore, divisible into a posterior or *visceral cavity*, and an anterior or *brachial cavity.*

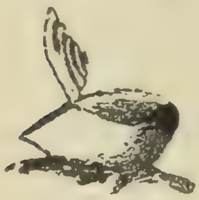


FIG. 98.—*Lacazella mediterranea*, with the valves open as in life. (LACAZE-DUTHIERS.)

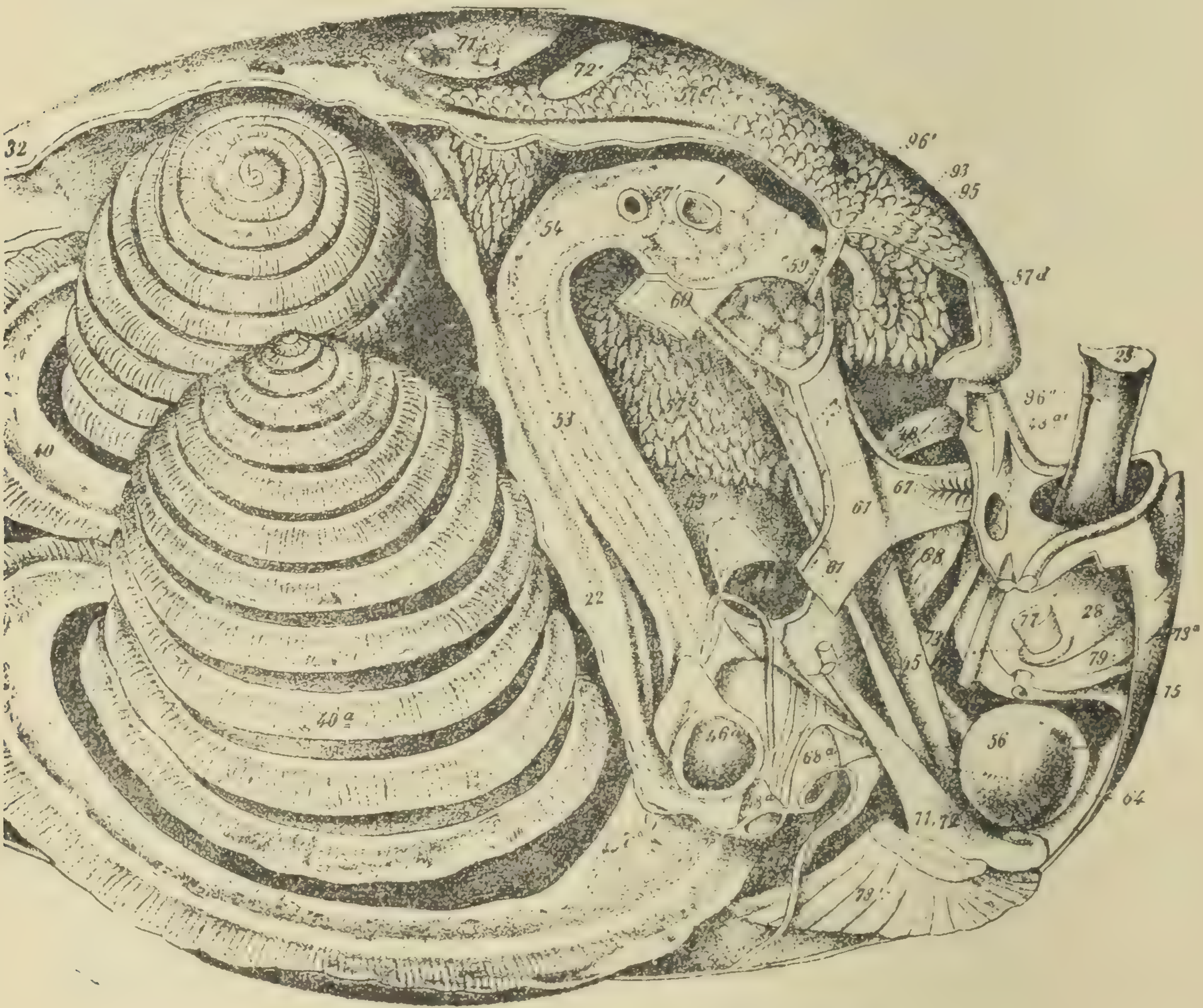


FIG. 99.—*Rhynchonella (Hemithyris) psittacea.*

The valves and a portion of the mantle removed, showing the vertical wall (22) dividing the body cavity into a posterior or visceral, and an anterior or brachial chamber. The notation of the other parts is as follows:

25, pedicle.
28, capsule of pedicle.
32, upper mantle lobe.
33, lower mantle lobe.
40, 40a, brachia.
46, 46a, brachial canal.
48, 48a, crural canal.
48a' aperture of same.
53, œsophagus.
54, stomach.
55, intestine.
56, blind extremity of intestine.
57, b, c, d, liver.
57', hepatic canals.
59, 60, gastroparietal band.
61,络 ilioparietal band.
63', 63'' mesentery.
64, genital organs.
67, ventral funnel of oviduct.
68, tube of same.
71, 72, 71', 72' anterior and posterior adductors.
73, 73a, diductors.
75, 77, accessory diductors.
79, pedicle-muscle.
93, heart.
95, aorta
96, pallial artery.
96' 96'' dorsal and ventral branches of same.

(BRONN after HANCOCK).

THE MANTLE.

This is a thin transparent membrane, appearing in the embryonic condition of the animal, as two distinct lobes. It is, primarily, the shell-secreting gland of the animal, and in all periods of growth it lines the entire inner surface of the shell.

In CRANIA, it is composed of three layers, a middle one, of compact, non-celluliferous tissue or cartilage, on each surface of which is a single layer of cells. From that which lies against the surface of the shell arise the cæca or blind tubes which enter the perforations of the test. At various points the mantle, or certain of its layers, folds upon itself, inclosing cavities or pallial sinuses which contain the circulating fluids and often portions of the genital organs. These sinuses frequently modify the interior

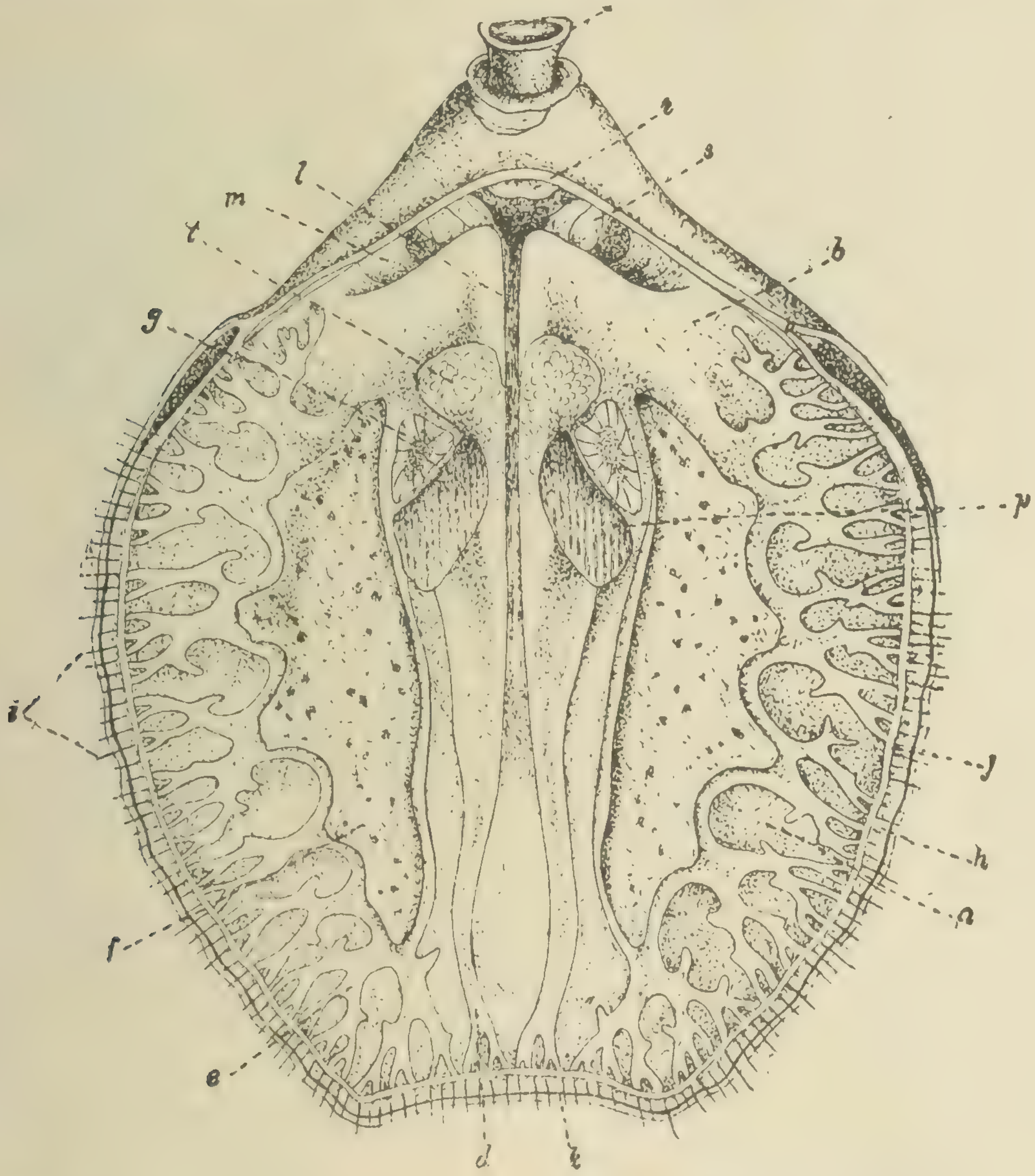


FIG. 100.—The animal of *Magellania australis*, viewed from the dorsal side.
a, mantle; *b*, body; *c*, pedicle; *d*, trunks of pallial sinuses; *e*, branches of pallial sinuses; *f*, genital organs; *g*, posterior adductor muscles; *h*, marginal fold of mantle; *i*, setæ; *j*, circum-pallial vessel; *k*, edge of mantle; *l*, median fissure corresponding to septum of valve; *m*, depression caused by hinge-plate; *p*, anterior adductor muscles; *r*, diductors; *s*, accessory diductors; *t*, liver.—(HANCOCK.)

of the valves so strongly that their traces are visible when the shell is petrified, and may be seen not only over the brachial region but also where the mantle is extended posteriorly between the margins of the visceral area and the edges of the valves (the *parietal region*).

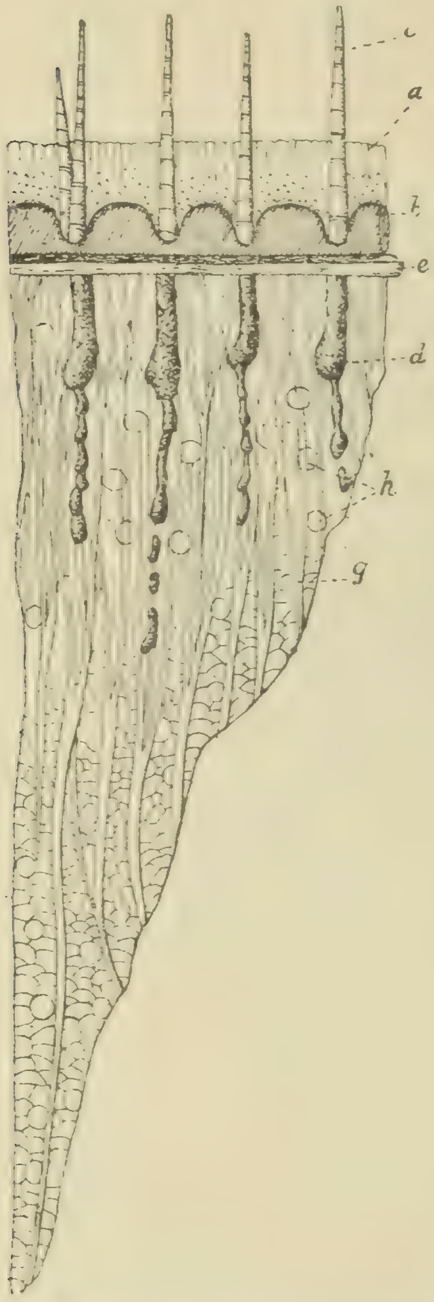


FIG. 101.—Marginal portion of the mantle of *Magellania australis*.
a, margin; *b*, marginal fold; *c*, setæ; *d*, follicles of setæ; *e*, circumpallial muscular belt; *g*, pallial muscles; *h*, bases of pallial cæca.—(HANCOCK).

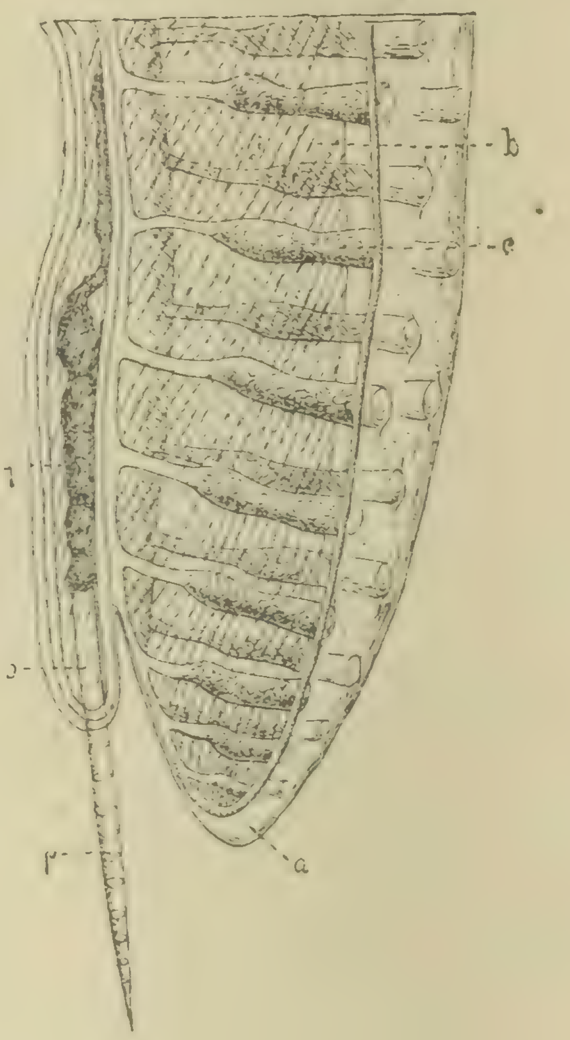


FIG. 102.—Vertical section of shell and mantle of *Magellania australis*.
a, margin of valve; *b*, shell showing prismatic structure; *c*, pallial cæca penetrating shell; *o*, marginal fold of mantle; *p*, one of the setæ; *q*, follicle of the same; *t*, extreme pallial margin.—(HANCOCK.)

In all the larger cavities of the body, including not only the greater sinuses of the mantle but also the perivisceral cavity and the cavernous brachia and cirri, are found calcareous spicules of various shapes which, in some genera, especially THE-

CIDIUM and its allies, unite to form an irregular mass or net-work. It is to a certain degree true that the spicules in a given species or genus have the same general aspect; and while they abound in most genera, there are a few (MAGELLANIA, TEREBRATELLA, LINGULA) in which they are absent, or have not been observed. The mantle extends to the edges of the valves and its outer margins are thickened, and set with stout chitinous setæ, each of which is lodged in a follicle or sac. The form and exterior of these setæ varies somewhat in different generic groups; in

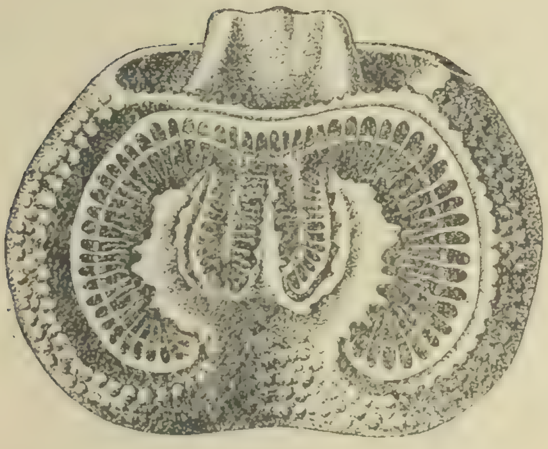


FIG. 103.—*Thecidium mediterraneum.* Interior of the brachial valve; showing the loose spiculization of the shell-substance about the brachia.—(WOODWARD.)

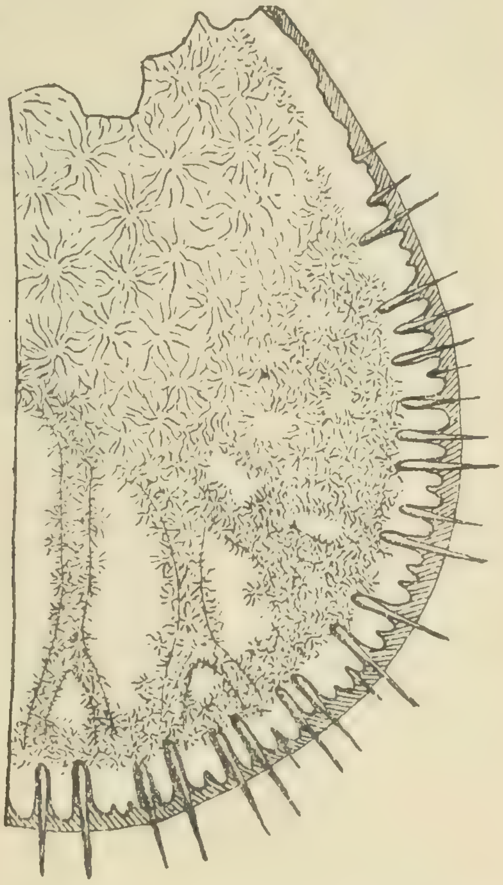


FIG. 104.—Portion of the mantle of *Terebratulina caput-serpentis*, showing spicules.—(HANCOCK.)

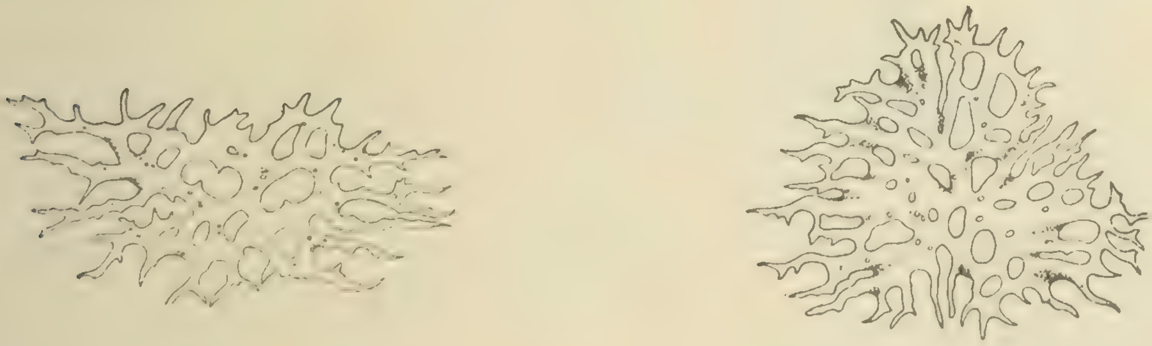


FIG. 105.—Spicules of *Terebratulina*, greatly enlarged.—(HANCOCK.)

DISCINISCA their edges are barbed. The function of the setæ seems to have been mainly protective, but in GLOTTIDIA, where they are of considerable length, they are said, by MORSE, to be an important aid to locomotion.

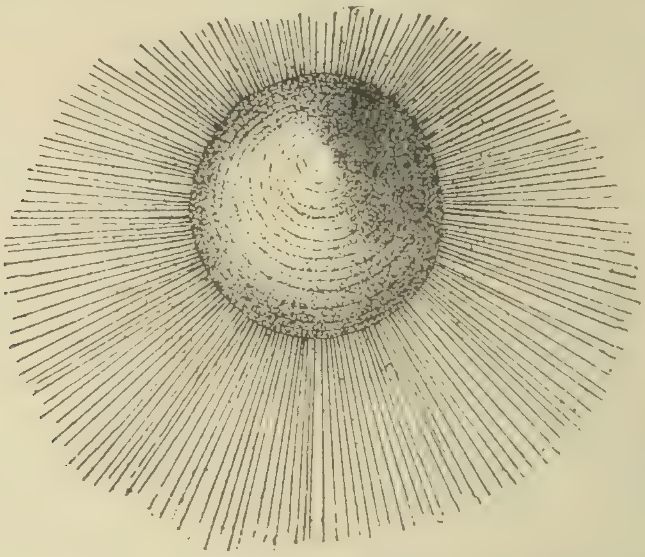


FIG. 106.—*Discinisca atlantica;* showing barbed setæ.— (DAVIDSON.)

THE PEDICLE.

This is the *organ of attachment* to extraneous bodies. In MAGELLANIA and the articulate brachiopods generally, it is a short, stout cylinder, whose inner extremity terminates in, and is attached to the umbonal surface of the pedicle-valve, its outer extremity being protruded through the delthyrium or the foramen in species or stages of growth, where the latter exists. Under other circumstances it may be protruded between the valves, or may be altogether functionless and atrophied at maturity, as is true of the greater part of early fossil species. This organ is a compact, inelastic cylinder of dense muscular tissue. The exposed portion is covered by a thick corneous sheath, and the inner extremity is received into a muscular capsule by means of which attachment to the pedicle-valve is effected. Within the corneous covering is a mass of muscular tissue.

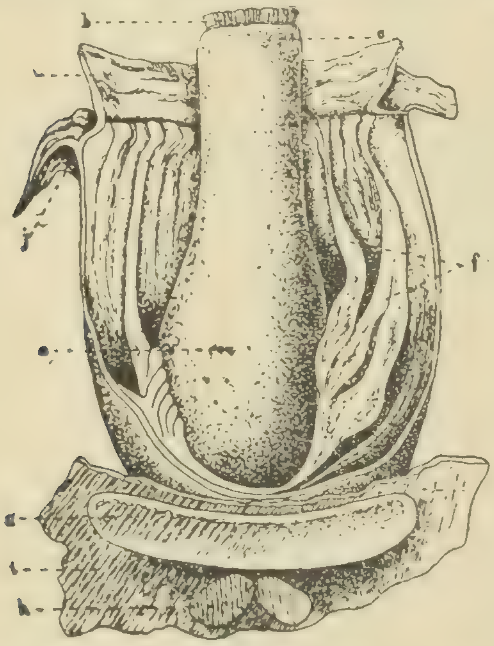


Fig. 107.— Pedicle of *Magellania australis* with capsule laid open. *a*, pedicle; *b*, muscular mass of same; *c*, horny sheath; *e*, margin of orifice leading into capsule; *f*, plications on inner surface of capsule; *g*, pedicle-muscle; *h*, assessory diductors; *i*, wall of perivisceral chamber (pedicle-valve); *j*, same (brachial valve).— (HANCOCK).

In LINGULA the pedicle is a very flexible, highly muscular body, often enormously developed in length. At its point of emergence from the valves, it is exceedingly thick, abruptly contracting from this point inward. It is composed of two layers; an outer, thin corneous one, and an inner muscular one. The organ is traversed for its entire length by a central canal which is connected with the chamber inclosing the viscera (*perivisceral cavity*). The capsule, so highly developed in the terebratuloids is here rudimentary, while the pedicle-muscle is well developed. In GLOTTIDIA the pedicle has been shown by MORSE to be annulated, supplied with mural pores, and the central canal to be filled by a circulating sanguineous fluid. It has already been observed that in *Glottidia Audebardi* the pedicle forms for itself a covering of agglutinated sand grains, etc., being otherwise unattached, and also possesses the power of contracting itself violently in all directions. All of these characters are very suggestive of relations to the Annelids, as has been forcibly argued by the author quoted.

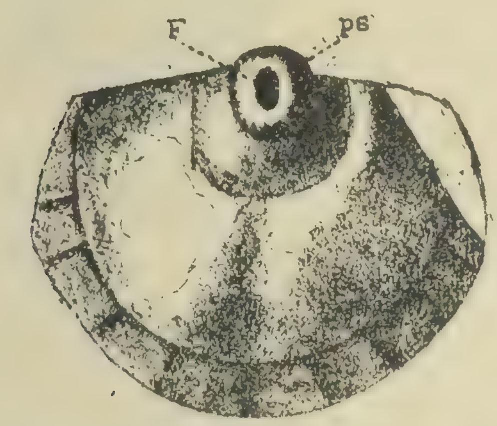


Fig. 108.—*Leptœna rhomboidalis.* A very young shell, x10. F, foramen; *ps*, pedicle-sheath. (BEECHER and CLARKE.) For the mature shell see plate 13, figs 2, 3.

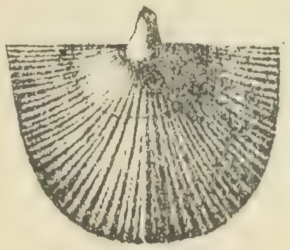


Fig. 109.—*Rafinesquina Ulrichi.* An adult shell with the pedicle-sheath highly developed.

MUSCULAR SYSTEM.

The Brachiopoda which are articulated by teeth and sockets can open and close their valves only in a vertical plane, and even in this direction the capability of motion is very limited. They also possess, to a limited degree, the power of protruding and retracting the pedicle. We therefore find in the articulate brachiopods *three* sets of muscles, namely: Those which by contraction open the valves (*diductors*), those which by contraction close the valves (*adductors*), and those which by contraction withdraw the pedicle (*pedicle-muscles*). The arrangement of these is uniformly simple, and the plan is not essentially varied

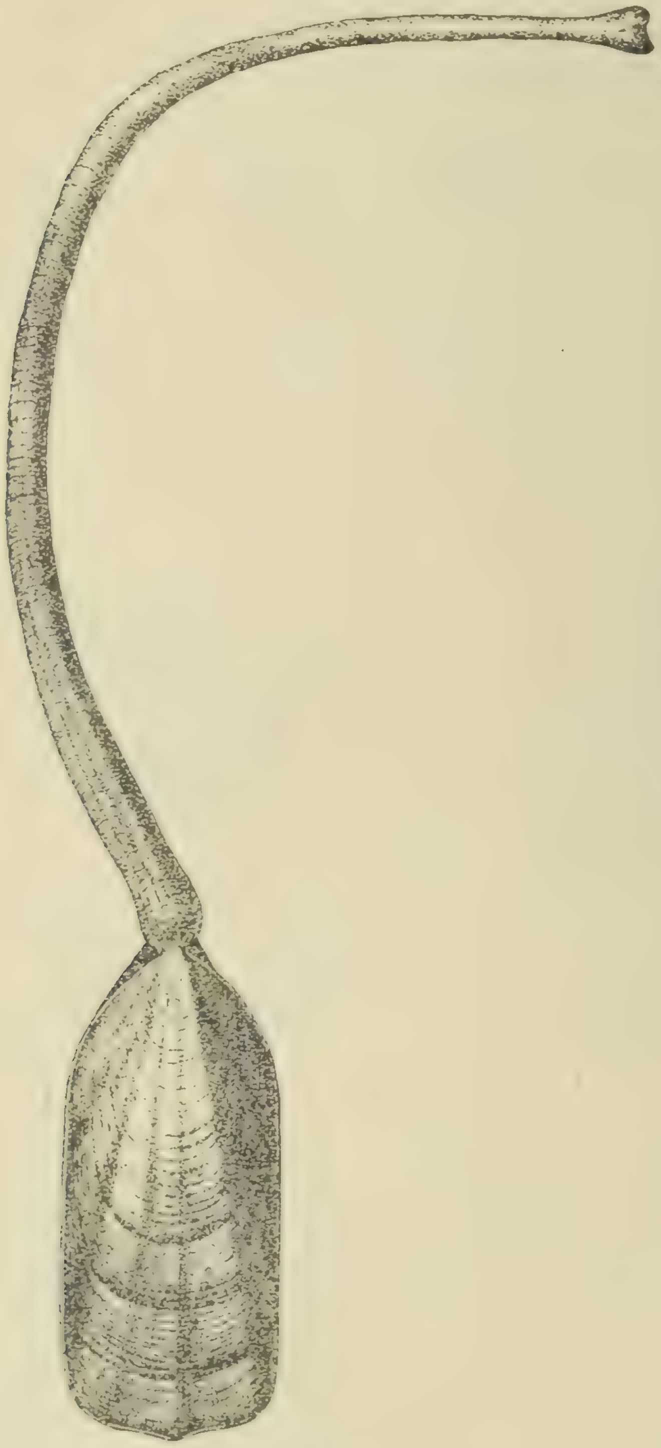


Fig. 110.—*Lingula Murphiana.* (DAVIDSON.)

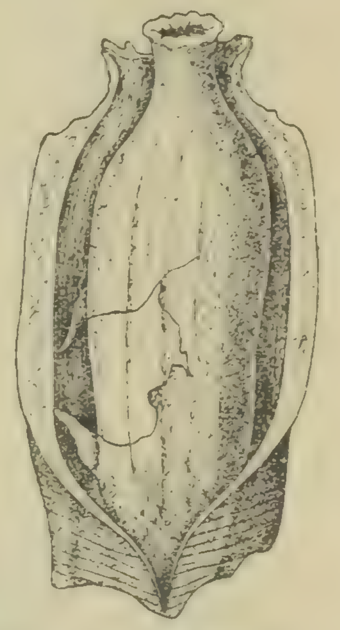


Fig. 111.—Extremity o pedicle of *Lingula anatina*, with horny sheath laid open, exposing the muscular cylinder and its membraneous coat. (HANCOCK.)

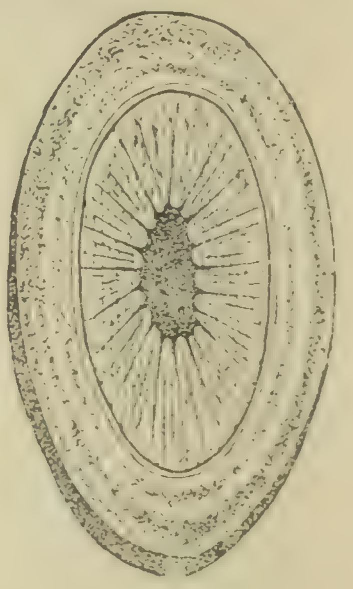


Fig. 112.—Transverse section of pedicle of *Lingula anatina*. (HANCOCK.)

throughout the articulate group. As to the valvular muscles, it is a noteworthy fact that the same muscular action (contraction) produces directly opposite results, on account of the difference in the position of insertion of the muscles of the brachial valve.

Thus, in the pedicle-valve of any living brachiopod like TEREBRATULINA or MAGELLANIA, the principal *diductor* or opening muscles take their origin at the anterior edge of the visceral area and on either side of the axial line. They rapidly diminish in size in crossing the interior cavity, and their small extremities are inserted on the anterior portion of the cardinal process of the brachial valve. These muscles are, almost without exception, the largest, and leave the deepest scars upon the shell of any in the animal. The reason of this is that the muscles by contraction act upon a very short lever-arm (cardinal process) through which they must overcome the resistance expressed in the weight of the entire body of the brachial valve attached by its posterior

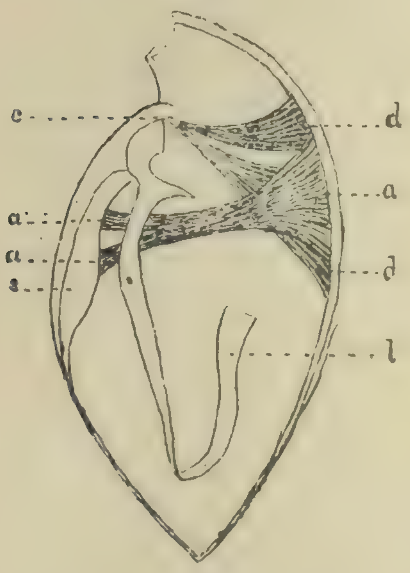


FIG. 113—Muscular system of *Magellania.* *a,* adductors; *d, d,* diductors; *c,* cardinal process; *s,* septum of brachial valve; *b,* brachial supports. (DAVIDSON).

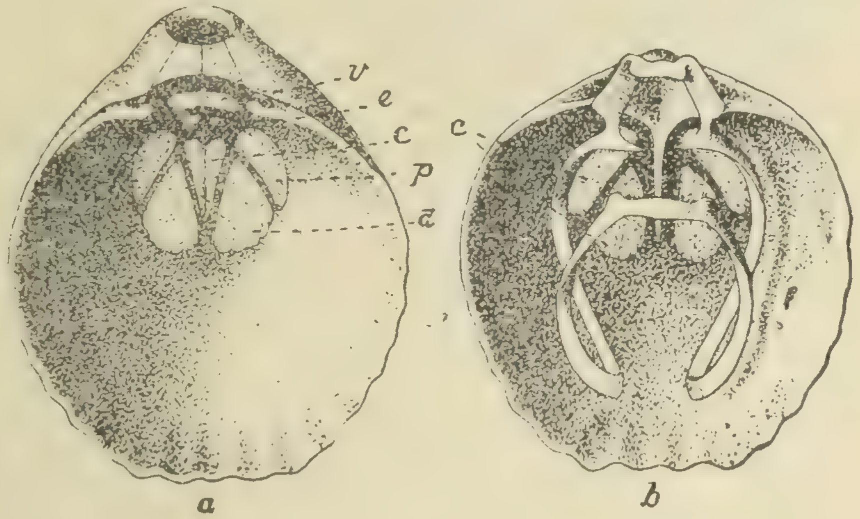


FIG. 114.—*Magellania flavescens.* *a,* pedicle-valve; *b,* brachial valve; *c,* adductor scars; *d,* diductors; *e,* accessory diductors; *p,* ventral pedicle-muscle; *v,* median pedicle-muscle. (DAVIDSON.)

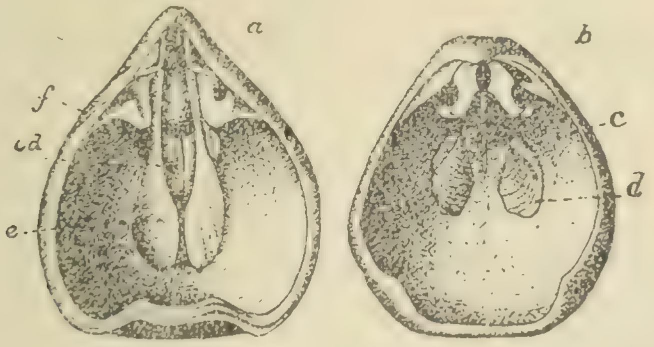


FIG. 115.—*Hemithyris psittacea.* *a,* pedicle-valve; *b,* brachial valve; *c,* posterior adductors; *d,* anterior adductors; *e,* diductors; *f,* pedicle-muscles. (DAVIDSON.)

margin. In species where the cardinal process is feebly developed, as in the plicated Spirifers, these muscles were very powerful, as is evinced by the deeply excavated scars they have left; so, also, in Orthis (Rhipdomella) and Hipparionyx (Plates 12, 16) the scars may cover a great part of the inner surface of the valve, extending almost to the anterior margin; while in other species where the cardinal process was larger and the leverage more equable, these scars are much feebler and of less size (Triplecia, Streptorhynchus, Stringocephalus; Plates 17, 18). In the posterior part of the muscular region of the pedicle-valve are two much smaller muscular bands (*accessory diductors*, see figure 114) which are inserted on the cardinal process behind the principal diductors. The scars of this pair are very rarely seen among the fossils, and it is doubtful if they existed among the early genera, such as Orthis, Strophomena, Stropheodonta, etc., where the principal diductors attained such great size.

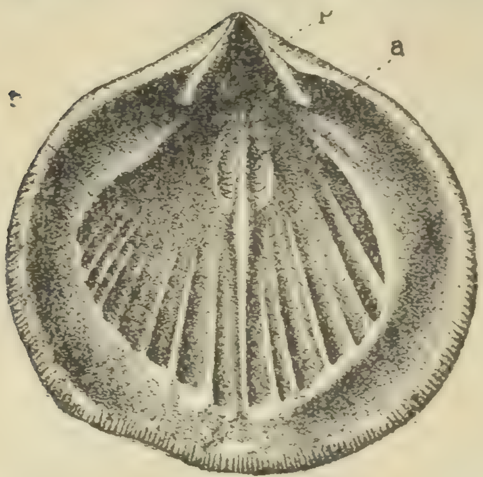


Fig. 116.—*Orthis musculosa.* Interior of a pedicle-valve: *a*, adductors; *r*, diductors; *p*. pedicle-muscle.

The *adductor* or *closing muscles* have a double origin on the pedicle-valve, leaving two elongate scars on either side of the median line, and lying between the scars of the diductors. They traverse the interior cavity almost perpendicularly to the valves, each muscular band dividing, and their insertion on the brachial valve being therefore quadruple. Their divisions on that side of the animal are known as *anterior* and *posterior adductors.* The central position of these muscles gives them a great mechanical advantage in closing the valves and they are therefore less powerful than the diductors; among the fossils they are often obscurely defined. The size and definition of these scars will always be found in direct relation to the amount of work required of the muscles. Thus in Stropheodonta and Productus their insertion upon the brachial valve is so far back that they are at a disadvantage in moving this valve; and in both of these genera, the scars are usually strong. In

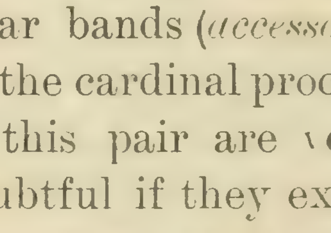


Fig. 117.—Interior of brachial value of *Orthis Vanuxemi. j*, cardinal process; *a*, *á*, anterior and posterior adductors.

SPIRIFER, on the other hand, where the mechanical advantage was greater, these impressions on the brachial valve are often scarcely discernible, and, as is often the case among the fossils, the quadruple division of the insertion on this valve is quite obscure.

Besides the valvular muscles, there are *two pairs* and a single *unpaired* muscle which are attached to the *pedicle.* One originates on the pedicle-valve at points just outside and behind the diductors; the other pair is attached to the brachial valve behind the posterior adductors, while the unpaired muscle lies at the base of the pedicle, attaching it closely to the pedicle-valve. Of all these muscles for the retraction of the pedicle, it is only the unpaired band that often leaves a discernible scar upon the valve, and in numerous fossil species where the pedicle early became atrophied, even this scar is covered by later depositions of testaceous matter. Among some of the inarticulate brachiopods the muscular system is quite as simple as in the articulates. In CRANIA there are *two pairs* of strong muscular bands, the one *median* and close together, the other *posterior* or *cardinal*, and further apart.

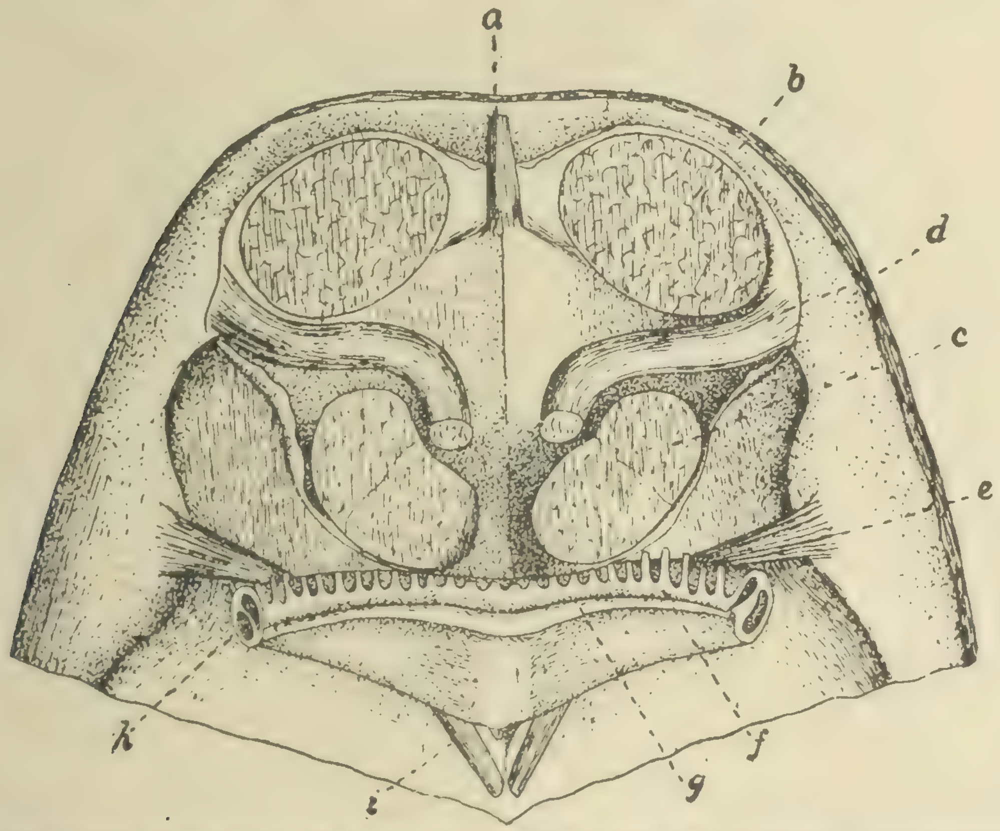


FIG. 118.—The muscular system of *Crania*. *a*, median unpaired muscle; *b*, posterior adductor; *c*, anterior adductor; *d*, protractor; *e*, brachial muscles; *f*, oral surface; *g*, brachial fold; *h*, arm; *i*,=*e*. (JOUBIN.)

The former (*anterior adductors*) close the valves, the latter (*posterior adductors*), by their contraction, *open* the valves to the very limited extent possible among these shells. In addition to these is a single small pair which is attached to both valves (*protractors* of the free valve), which effects a slight forward and backward movement of the upper valve. Two other small muscular pairs are attached to the brachia, and have their origin on one of the valves (*protractors* and *retractors* of the brachia). There is also a small unpaired muscle originating on the surface of the upper valve, close to the margin and in the median line; this is attached to the viscera, and according to JOUBIN, by its contraction the passages from the genital organs are opened.

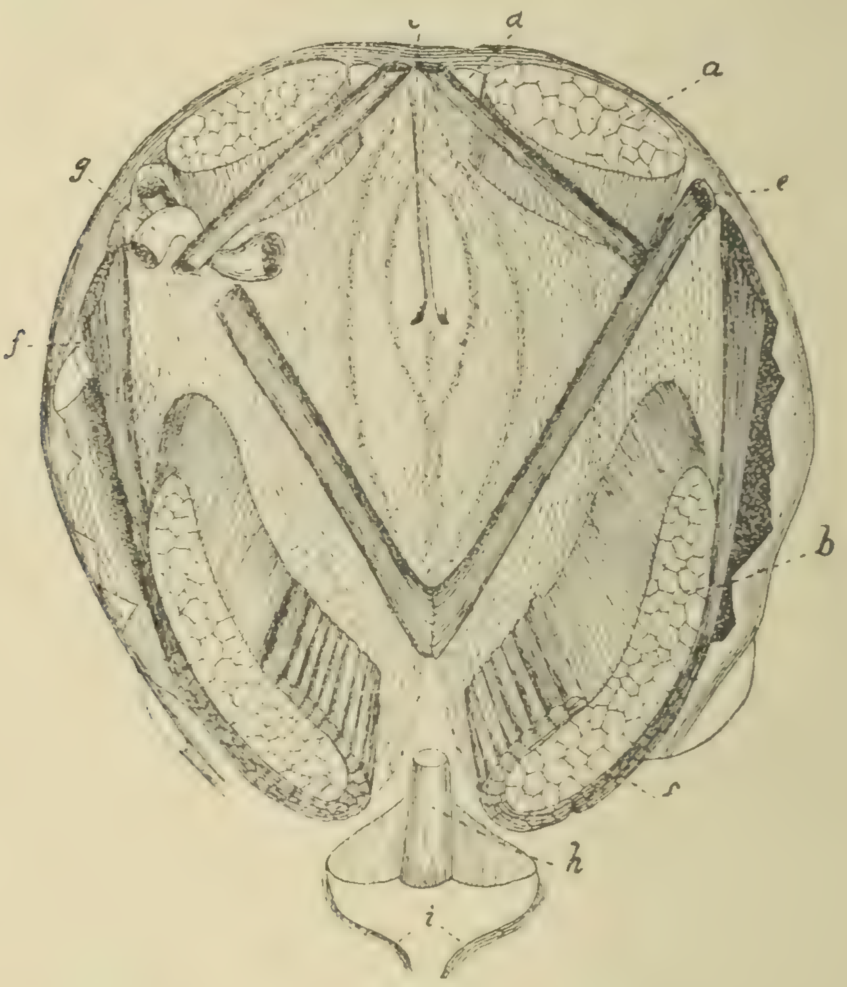


FIG. 119. — Muscular system of *Discinisca*, the muscles remaining attached to the pedicle-valve-*a*, posterior adductor; *b*. anterior adductor; *c*, median unpaired muscle; *d*, posterior pro. tractor; *e*, anterior protractor; *f*, retractor; *g*, intestine; *h*, œsophagus; *i*, arms. (JOUBIN.)

In DISCINISCA the arrangement of the muscles is very similar, there being two pairs, instead of a single pair of *protractors*, which slide the upper or brachial valve outward over the edges of the attached valve, while a single pair of *retractors* draws the valve into place again. There is also here an unpaired median muscle which is probably an organ of retraction of the pedicle.

In LINGULA and its allies the muscles are more numerous and their arrangement far more complicated than in other brachiopods. These animals possess the power of separating the valves in a manner unlike that of other members of the class; that is, of sliding them apart laterally or rotating them through a short arc about the longitudinal axis of the shell. The muscular area occupies a relatively large portion of the internal surface, the bands being arranged about the margins of the visceral area. In the umbonal region there is a central, undivided muscle, crossing the interior cavity vertically; this is the *umbonal* or *diductor* muscle, by its contraction opening the valves along their anterior margins.

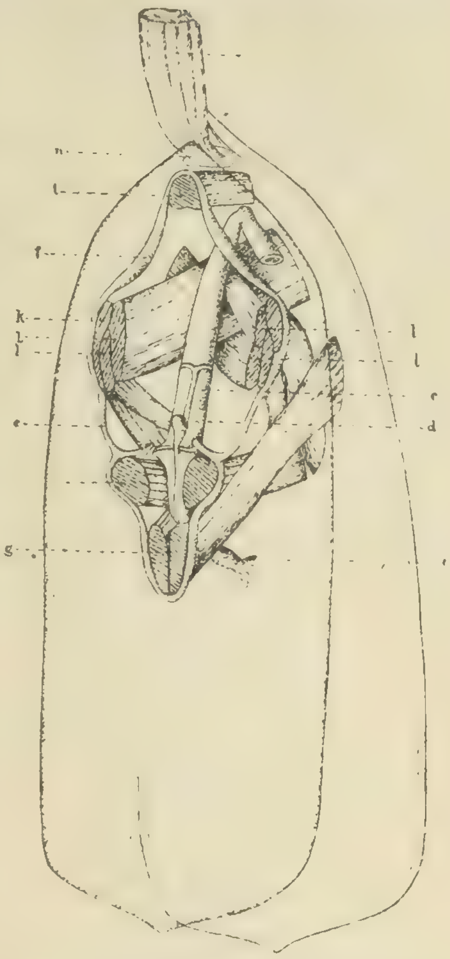


FIG. 120. — Muscular system of *Lingula anatina*: *c*, alimentary canal; *d*, dorsal vesicle; *e f*, walls of perivisceral cavity; *g*, retractors; *h*, adductors; *i*, umbonal; *j k*, protractors; *l*, rotators; *m*, pedicle; *n*, pedicle muscle.—(HANCOCK).

The *adductors* (or *centrals*) are a single pair situated near the anterior extremity of the area, and they also cross the shell cavity vertically. At the anterior extremity of the area in the pedicle valve originates a single pair of *protractors* (*middles*), each member of which extends backward and is inserted near the lateral margin of the brachial valve, while a second pair of *protractors* (*externals*) originates just behind the adductors of the pedicle-valve and is inserted behind the first pair. These muscles, by their combined action, or independently, draw the brachial valve forward. The *retractors* (or *anteriors*), or those which readjust the brachial valve, extend from the outer lateral margins of the area in the pedicle-valve to its anterior extremity in the brachial valve. Neither *protractors* nor *retractors* cross the perivisceral cavity. The *rotators* (*transmedian* or *sliding-muscles*) are three in number, two on one side and three on the other. These are situated posteriorly and cross the perivisceral cavity diagonally, the undivided muscle passing between the other two. The contraction of these, alternately rotates the brachial valve, first in one direction and then in the other. In LINGULA, also, the *paries* or vertical extension of the mantle which incloses the viscera is highly muscular and leaves an impression on the valves. In ancient and fossil forms of LINGULA it is evident that the arrangement was similar to that of living species, and though specimens have been rarely seen which show the muscular scars clearly, a few have been recorded which have retained the scars with great distinctness. In OBOLUS, MICKWITZ finds that, while the general arrangement of the scars is similar to that of LINGULA, the umbonal diductor is simple at its insertion in the brachial valve, and divides in crossing the cavity. This author also ascribes two distinct pairs of scars to the *rotators*, one to the *adductors* and another pair which may be either adductors or a third pair of rotators.

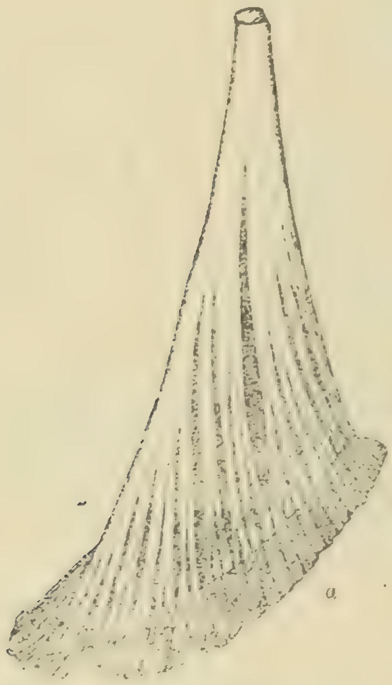


FIG. 121.— Extremity of adductor muscle of *Magellania australis*. *a*, contractile portion; *b*, tendinous portion. (HANCOCK.)

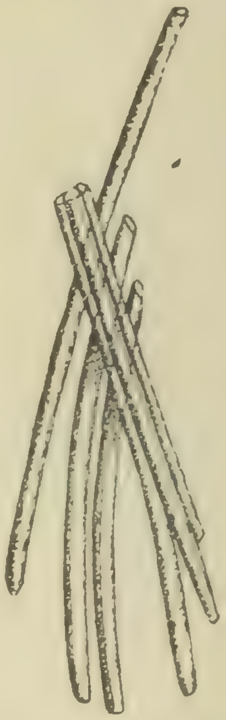


FIG. 122.— Non-striated muscular fibers of *Magellania australis*. (HANCOCK.)

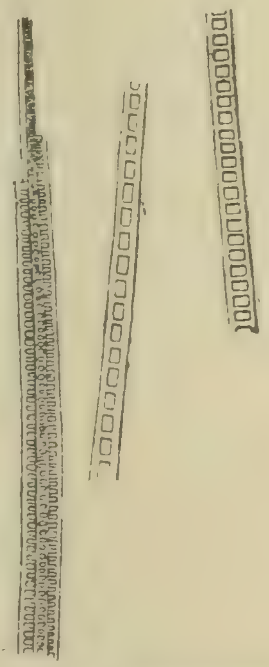


FIG. 123.—Striated posterior adductor or muscular fibers of of *Magellania australis*. (HANCOCK.)

There are some differences in the appearance of the muscular bands in the articulate and inarticulate brachiopods, those of the former tapering from origin to insertion, while in the latter they are of more equal thickness throughout. The muscular fibers are smooth, except in the posterior adductor bands where they striated.

ALIMENTARY SYSTEM.

The *mouth* is a simple orifice located centrally at the base of the fleshy brachia. In MEGATHYRIS the oval or buccal area is very broad, but in most brachiopods it is narrowed to a simple groove.

From this point the digestive tube extends backward as a simple bent canal, the flexure being toward the pedicle-valve. In inarticulate species it is much longer and more complicated than in MAGELLANIA, RHYNCHONELLA and the articulates generally. In LINGULA the digestive tube is very long and at the œsophagus is deflected ventrally; the stomach is short, rather more circular than elongate and the intestine makes three or four convolutions; in DISCINISCA and CRANIA there are some variations in the degree of convolution of this tube. In all of the living inarticulated species the intestine terminates in a well-defined *anus*, situated laterally in LINGULA, and in the median line in CRANIA.

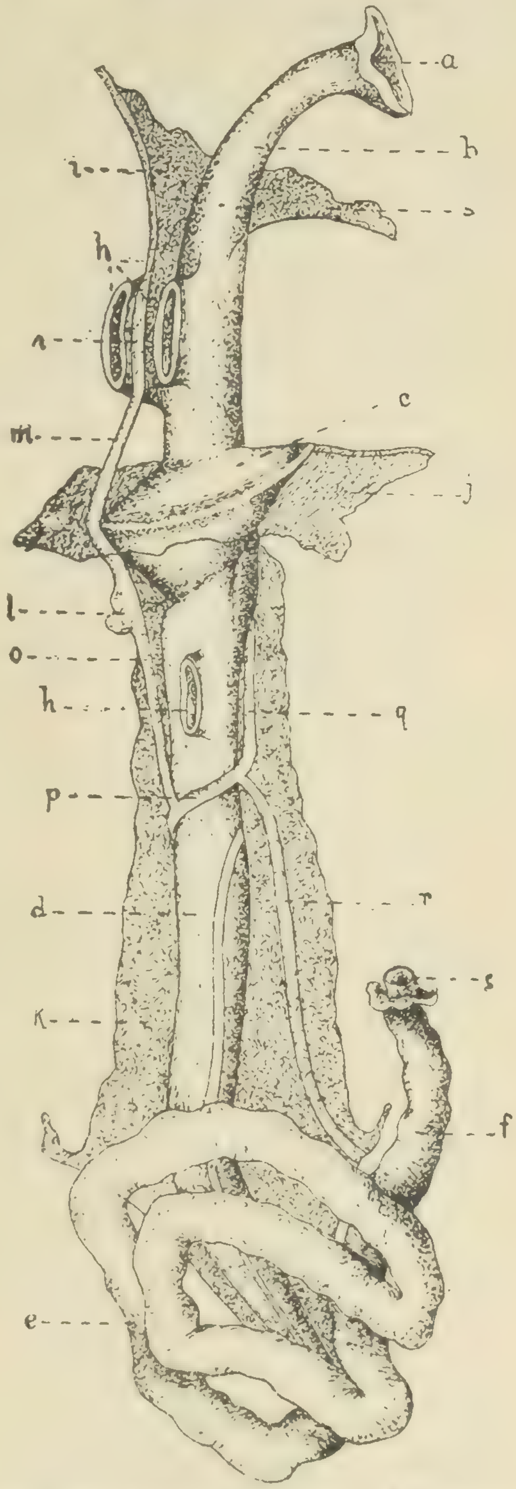


FIG. 124.—Alimentary canal of *Lingula affinis*; *a*, mouth; *b*, œsophagus; *c*, stomach; *d*, intestine; *e*, convolutions of same; *f*, rectum; *g*, anus; *h*, hepatic ducts; *i*, dorsal mesentery; *j*, gastro-parietal bands; *k*, ilio-parietal bands; *l*, dorsal vesicle; *m*, *n*, *o*, *p*, *q*, *r*, blood-vessels; *s*, œsophageal membrane. (HANCOCK.)

In the articulates the alimentary canal is shorter and much simpler than in LINGULA, CRANIA, etc. In MAGELLANIA the *œsophagus* is short, and behind it the tube is slightly contracted, then expanding again into a moderately capacious *stomach*. The *intestine* is short, and toward its posterior extremity makes a single convolution near the hinge-plate of the brachial valve, and it is probable that, in some of the extinct genera, e. g. RENSSELÆRIA, CENTRONELLA, ATHYRIS, in which this plate is perforated by a central foramen, the intestine passed through it. The posterior end of the intestine is imperforate in all articulated brachiopods, and in MAGELLANIA it is a simple point attached to the *parietes* or lining membrane of the perivisceral cavity. The presence or absence of this terminal perforation is, therefore, of considerable importance in the classification of these animals, and has been made a basis of subdivision by KING, who proposed thereupon the ordinal divisions *Tretenterata* and

Clistenterata (=*Inarticulata* and *Articulata*, respectively). It is believed that in the Articulata the faeces are discharged through the mouth.

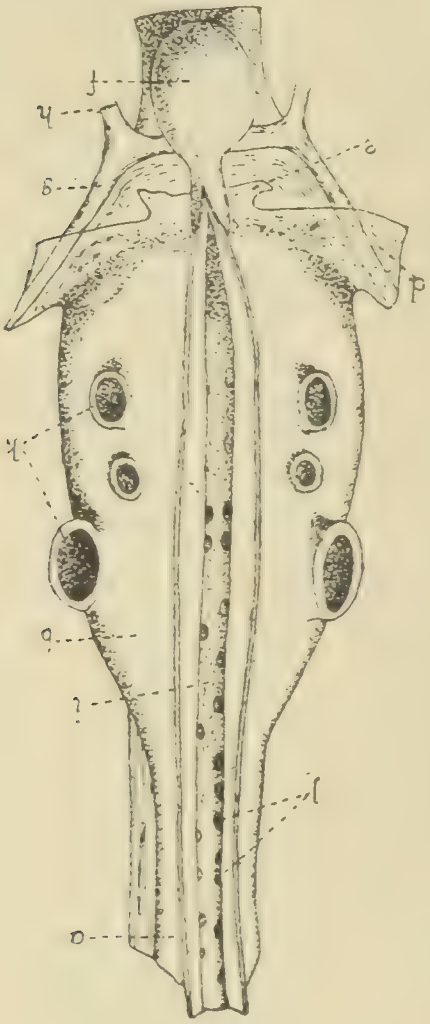


FIG. 125.—Stomach of *Magellania australis*. *a*, œsophagus; *b*, stomach; *d*, *e*, gastroparietal band; *f*, dorsal vescicle; *g*, *h*, blood-vessels; *i*, dorsal blood-vessel laid open, showing (*j*) orifices leading into gastral lacunes; *k*, hepatic ducts. (HANCOCK.)

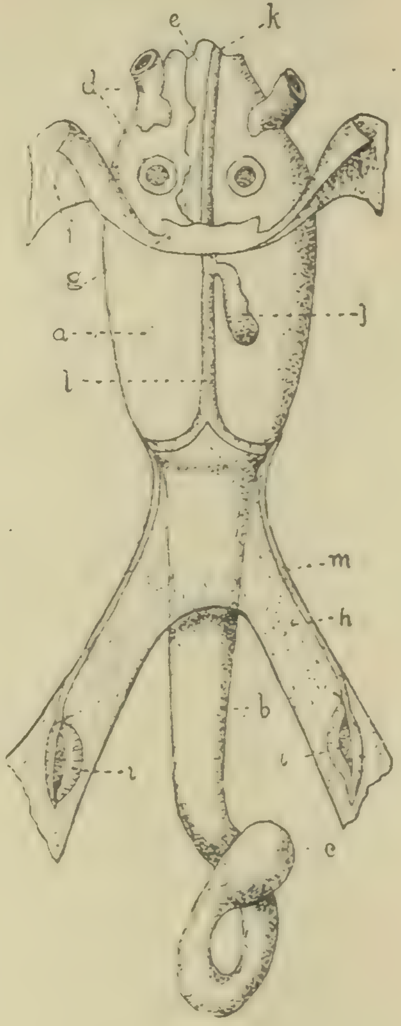


FIG. 126.—Alimentary canal of *Hemithyris psittacea*. *a*, stomach; *b*, intestine; *c*, imperforate extremity; *d*, hepatic ducts; *e*, dorsal mesentery; *f*, gastro-parietal bands; *g*, central band; *h*, ilio-parietal bands; *i*, oviducts; *j*, dorsal vescicle; *k*, *l*, vein; *m*, pallial sinuses. (HANCOCK.)

The entire tube is composed of firm tissue divisible into a fibrous outer coat and an inner mucous lining which is strongly plaited and wrinkled in the stomach and intestine. Externally it is sheathed by a tenuous membranous coat from

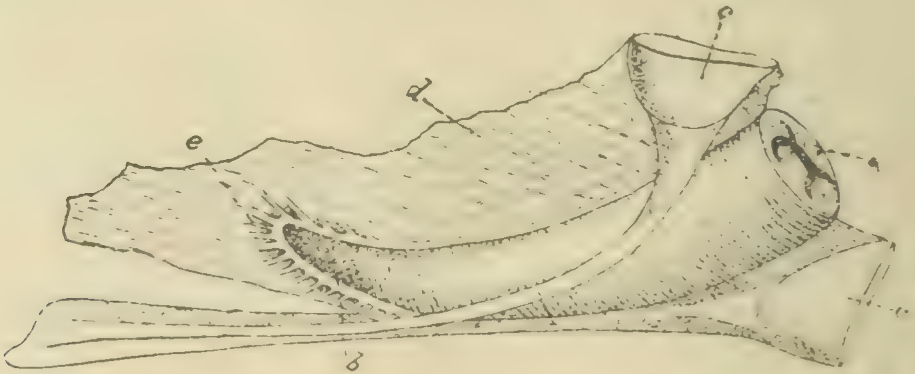


FIG. 127.—Intestine of *Magellania australis*. *a*, upper extremity; *b*, posterior cæca extremity; *c*, portion of oviducts; *d*, ventral mesentery; *e*, thickened ridges of mesentery; *f*, blood-vessel. (HANCOCK.)

which is given off a number of mesenteric bands connecting with the walls of the perivisceral chamber. The stomach is usually enveloped by an ample *liver* of brownish or greenish hue lying

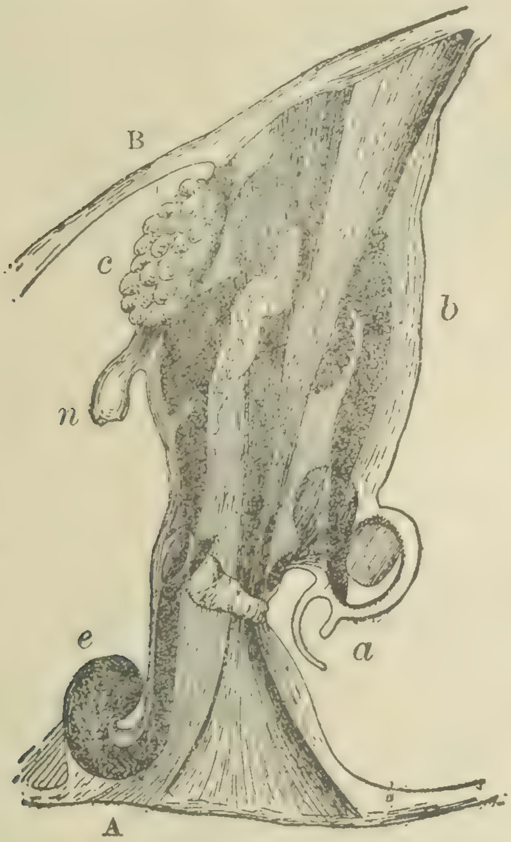


FIG. 128.—The alimentary and muscular system of *Rhynchonella (Hemithyris) psittacea*. (HUXLEY). *a*, mouth; *b*, œsophagus; *c*, stomach and liver; *e*, imperforate rectum: *n*, pyriform vesicle; A, pedicle-valve; B, brachial valve.

for the most part on the dorsal side, in the articulates, and on the ventral side in the inarticulates.

This glandular organ is composed of a varying number of cæcal tubes terminating in follicles or lobules, and discharging into the stomach at different points, usually at the sides. These hepatic canals would seem to serve in some measure a digestive function, as they have been found to contain the food of the animal, and, in RHYNCHONELLA, to undergo peristaltic contractions of the tube-walls.

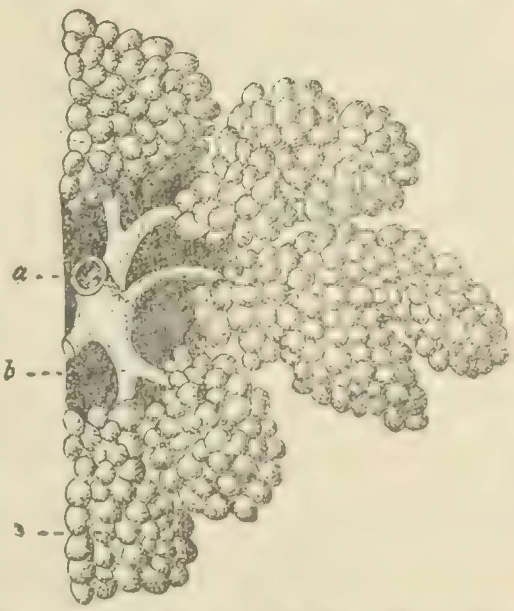


FIG. 129.—A portion of the liver of *Crania*. *a*, hepatic canals: *b*, canal of the lobules; *c*, lobules (JOUBIN.)

In a certain series of linguloid genera (LINGULOPS, LINGULASMA, TRIMERELLA, etc.) there appears to have been a gradual development of a testaceous thickening beneath the insertion of the muscular bands. This thickening or *platform* becomes slightly excavated on its anterior margin in LINGULOPS, more deeply in

LINGULASMA, while in TRIMERELLA and DINOBOLUS the platform is deeply vaulted. The development of these platform vaults does not proceed *pari passu* on both valves, but appears first and is always the deeper on the pedicle-valve. The upper surface of the platform always remains the area of muscular insertion, and it seems highly probable that the vaults have been formed by the necessity for the accommodation of the great hepatic and genital glands; there can be little doubt, at least, that when these chambers are fully developed they are occupied by these organs. A similar feature occurs in an oboloid genus, LAKHMINA, and it is probable that among some of the articulate genera, where the anterior edge of the muscular area is conspicuously elevated (as frequently in *Leptæna rhomboidalis* and *Productus humerosus*) a similar cause has been efficient. Such structures are not to be confounded with excavations of the valves due to the deposition of shell-matter about the ends of the muscles, leaving the scars of the latter deeply sunk, as in many of the Spirifers. (Plates 23–28).

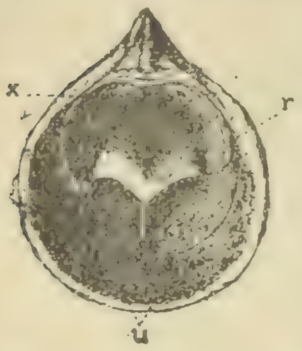


FIG. 130.—*Rhinobolus Davidsoni* Interior of pedicle-valve showing vaulted platform

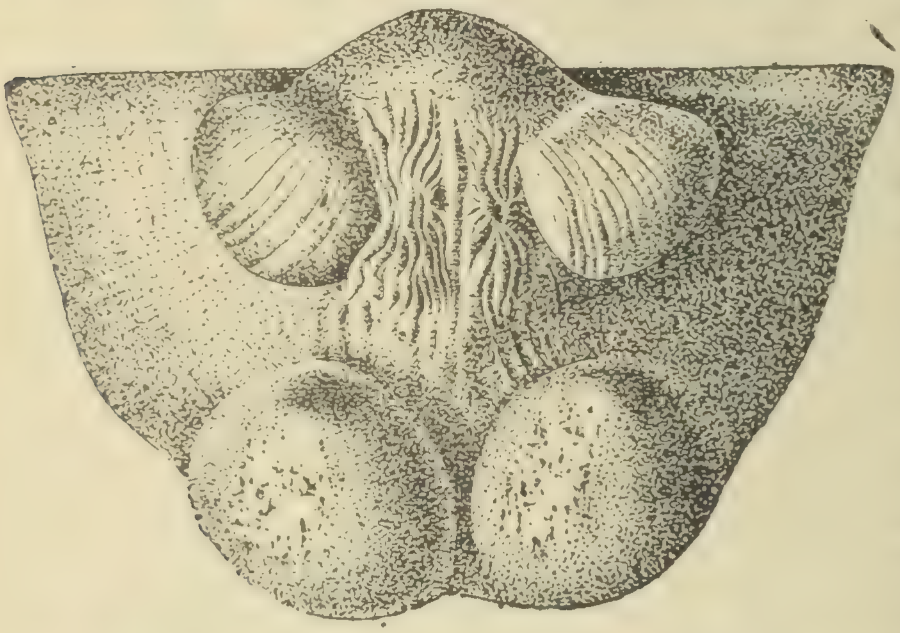


FIG. 131.—Cardinal view of an internal cast of the pedicle-valve of *Productus humerosus;* showing the filling of the great median cavities or vaults, lying in front of the muscular scars. (DAVIDSON.)

CIRCULATORY SYSTEM.

The most striking and most distinctly specialized part of the circulatory system is the series of canals which traverse the mantle, lying within the tissue of the mantle itself. These canals consist generally of two main trunks diverging from the anterior portion of the perivisceral chamber and skirting the margins of the visceral area, giving off secondary branches and ramuscules which are abundantly multiplied at the margins of the mantle. These *pallial sinuses* are frequently so highly developed as to modify the inner surfaces of the valves, and traces of them are often retained when the latter are fossilized. In SCHIZOPHORIA there a few simple trunks restricted to the median portion of the valves, branching only at their extremities; in such shells the lateral expansions of the valves must have been nourished by sinuses too small to leave their traces on the valves.

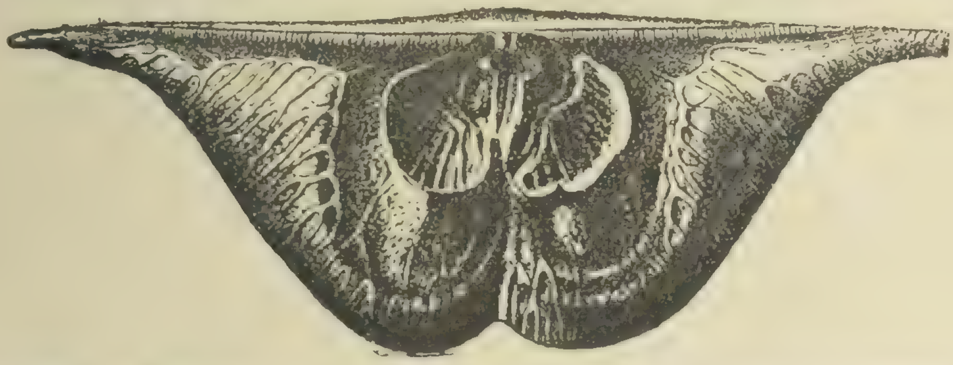


FIG. 133.—Interior of pedicle-valve of *Strophonella cœlata*; showing muscular impressions and pallial sinuses.

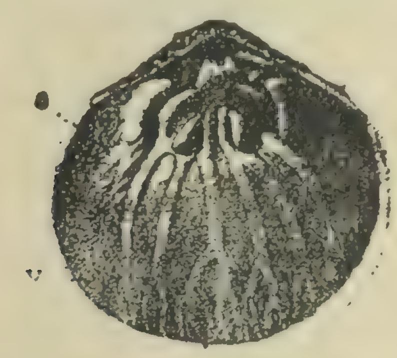


FIG. 134.—Internal cast of brachial valve of *Schizophoria impressa*. *v*, vascular trunks; *o*, genital markings.

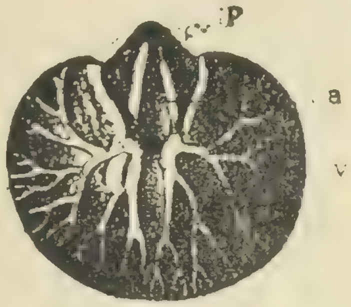


FIG. 135.—*Orthis subcarinata*. An internal cast, showing the pallial sinuses; *p*, impression of pedicle muscle; *a*, impression of diduductor muscles; *v*, vascular sinuses.

In CRANIA and CRANIELLA the sinuses are broad, digitate and not sharply defined, in the one; sinuous and without apparent connection with the other.

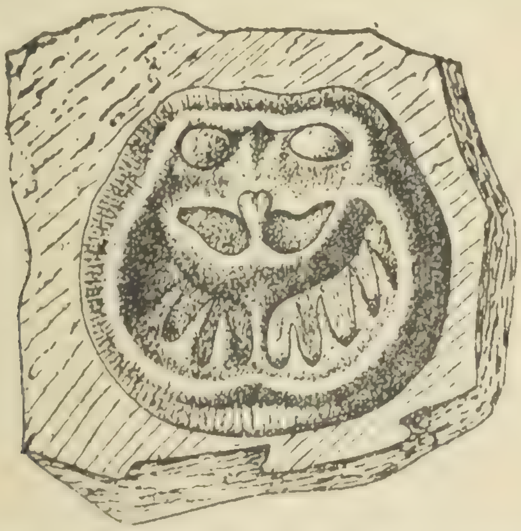


FIG. 136.—*Crania anomala*: showing the vascular and muscular impressions of attached valve. (DAVIDSON.)

In LINGULA and its allies there are two main trunks which converge toward the anterior margin of the valves, and give off not only an outer but a smaller inner series of branches. The main trunks of the pallial sinuses are the receptacles of a portion of the genital organs, but this fact does not interfere with their circulatory function. Similar canals traverse the fleshy brachia for their entire length. In Lingula there are three of these lying side by side; one very large and central, a much smaller one at the base of the cilia, the third being lacunary and lying in the brachial fold. In Crania and Rhynchonella the last-mentioned of these is absent. All the vascular sinuses pass into the perivisceral chamber and are developed into vescicular dilatations at the back of the stomach and elsewhere. These bodies are not contractile, and their function is at present unknown (Huxley). There is no pulsatile vescicle in the animal which performs the function of a heart, and circulation seems to be maintained by means of the ciliated tissue with which the sinuses are lined. Although there is no communication between these vessels and the walls of the perivisceral chamber, it is the opinion of some authors (Huxley) that these walls, which are also ciliated, contribute to this function.

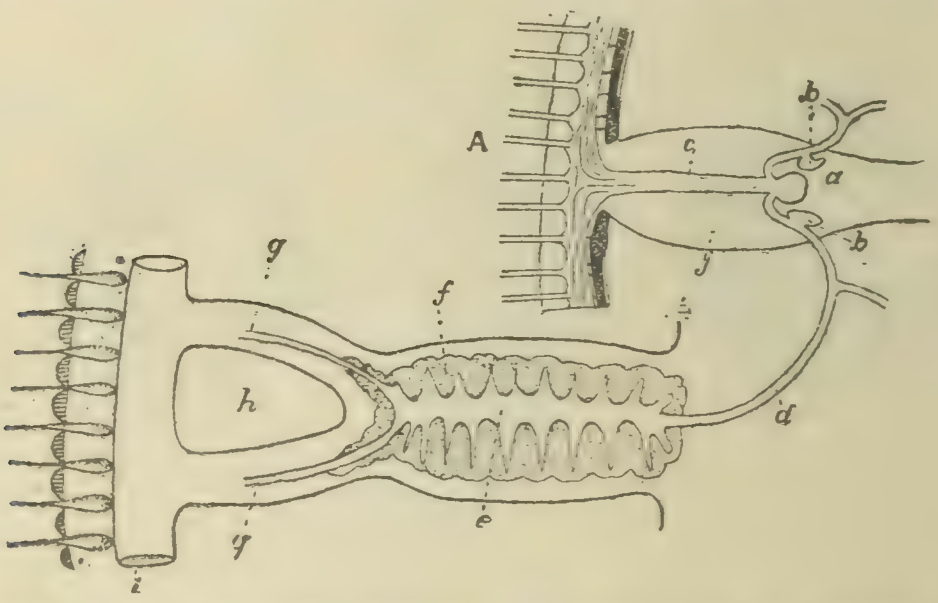


Fig. 137.—A portion of the circulatory system in *Magellania venosa*. Above the right is the ciliated oral surface (*A*), the stomach and intestine (*j*), upon whose dorsal surface is situated a central heart (*a*) sending an aorta (*c*) to the brachia, and giving off two lateral branches, each of which bears a pulsatile sac or subsidiary heart (*b*). The lateral vessels (*d*) supply the genital gland (*f*), and terminate (*g*) within the peripheral lacune (*i*) lying at the base of the setæ (*B*) which border the mantle (*h*). (Joubin.)

In Lingula, Morse has observed the existence of caecal extensions of the sinuses or *ampullæ* scattered over the inner surface of the mantle, which are highly contractile and receive and discharge the circulating fluid with perfect regularity.

As observed by ŒHLERT, "the body-walls, the oviducts and the genital glands are in direct connection with the blood; and the intestine, the muscles and the liver are enveloped by membranes so delicate that they can not obstruct the action of the nourishing fluid."

RESPIRATION.

The function of respiration has no special organ or set of organs for its performance; it is not localized, but is evidently effected wherever the tenuous tissue of the animal with its circulatory vessels is exposed to the oxygenated water. The mantle is principally concerned in this function, and the long spiral brachia undoubtedly contribute, though perhaps not to the extent attributed to them by some authors, who have compared them to, and regarded them as branchiæ or gills.

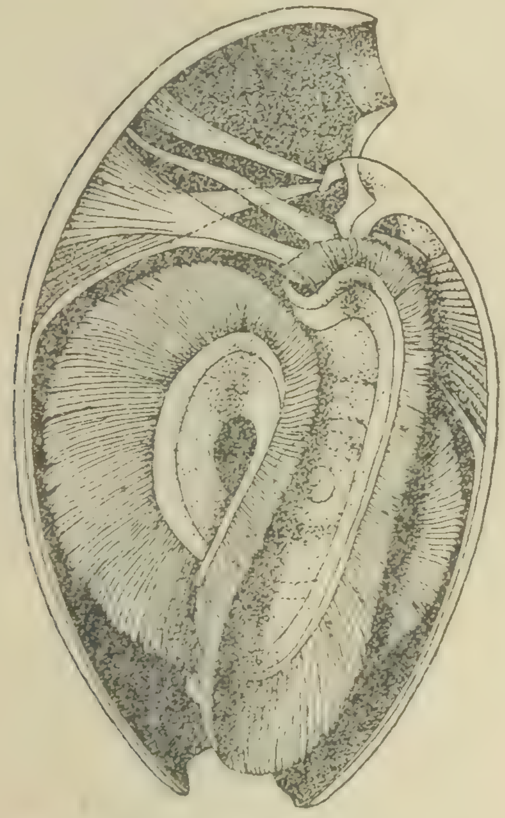


FIG. 138.—*Magellania flavescens;* showing the brachia. (DAVIDSON.)

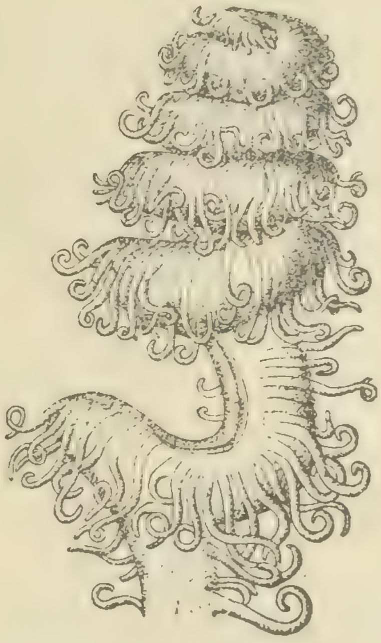


FIG. 139.—Extremity of the arm of *Crania.* (JOUBIN.)

The water entering the brachial chamber of the shells is constantly renewed by the opening and shutting of the valves, and perhaps more effectively by the constant play of the cilia with which the outer edges of the arms are fringed.

In this place a brief account of these arms, their variations in form and the nature of their calcified supports will be given.

Brachia. The brachia are labial appendages taking their origin about the oral opening and extending in various graceful curves and spirals into the anterior chamber of the valves. They are two in number, one at each side of the mouth.

These arms are substantially composed of a compact or cartilaginous tissue which is perforated for its entire length by several canals, to which reference has been made in the description of the circulating apparatus. The outer edge of the arms bears the *cirri*, which are kept in motion partly by muscular contraction and partly by the filling and emptying of the brachial canals. At the base of the cirri is a loose membranous expansion or flap, known as the brachial *fold* or *lever*.

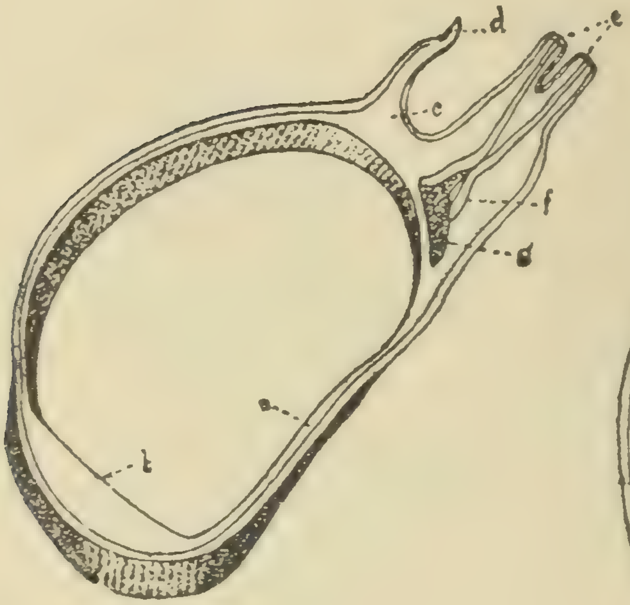


Fig. 140.—Transverse section of arm of *Hemithyris psittacea.* *a*, *b*, wall of great brachial canal; *c*, grooved ridge; *d*, brachial fold; *e*, bases of cirri; *f*, expanded orifices of cirri, opening into canal *g*. (Hancock.)

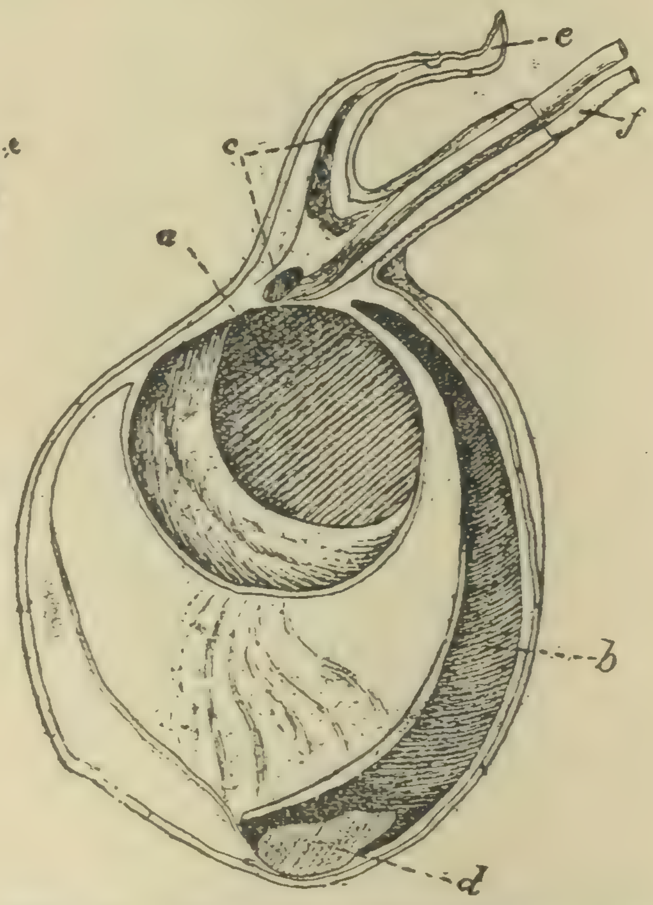


Fig. 141.—Transverse section of arm of *Lingula anatina*. *a*, central brachial canal; *b*, posterior canal; *c*, lacunes; *d*, longitudinal muscle; *e*, brachial fold; *f*, bases of cirri. (Hancock.)

In a few of the living genera (Lingula and Rhynchonella) and in a great number of the extinct forms (Spirifer, Athyris, Rhynchospira, Rafinesquina, etc., etc., and probably Orthis) the arms are coiled in long spiral cones, the extremities of which may be directed outward (Spirifer, Athyris), inward (Rhynchonella, Zygospira), dorsally (Atrypa), ventrally (Amphiclina) or the spirals may be nearly in a vertical (Cyclospira) or a horizontal (Lingula) plane; and the number of revolutions in the spiral varies from two or three (LINGULA, CYCLOSPIRA) to twenty-five (*Spirifer mucronatus*).

In the majority of living forms (LIOTHYRINA, MAGELLANIA, MAGASELLA, MÜHLFELDTIA, KRAUSSINA, etc., etc.), the arms extend forward from the mouth or oral disk to the anterior margin of the valves, recurving toward the mouth, and there forming a short unpaired spiral in the axial line. While these are the principal variations in the arrangement of these parts, a notable difference is presented by MEGATHYRIS, THECIDIUM and their allies, in the complete attachment of the arm to the brachial valve by its lower margin. The area thus inclosed by the brachia is frequently large (*Megathyris decollata*) and it may be divided on its outer margin into three or more deep lobes. Living species whose brachia do not rest upon solid, calcified supports may possess the ability to uncoil and protrude the brachia between the open valves. This has been observed in RHYNCHONELLA (OWEN, MORSE), though it is doubtful if it is possible to the animal of LINGULA. In *Terebratulina caput-serpentis*, which possesses a short, solid brachial support, the animal can extend only the outer free margins of the arms and then but for a very short distance (BARRETT).

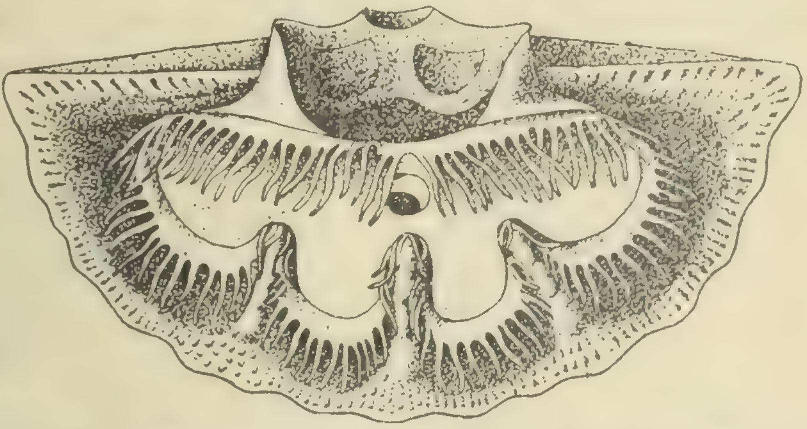


FIG. 142.—Brachial valve of *Megathyris decollata*, showing the arms attached by their lower margin about the expanded oral disk. (WOODWARD.)

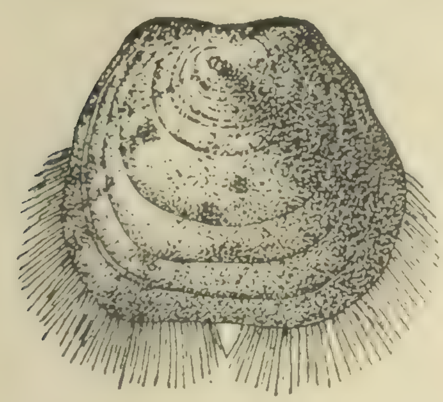


FIG. 143.-*Crania anomala*, with arms extended. (DAVIDSON.)

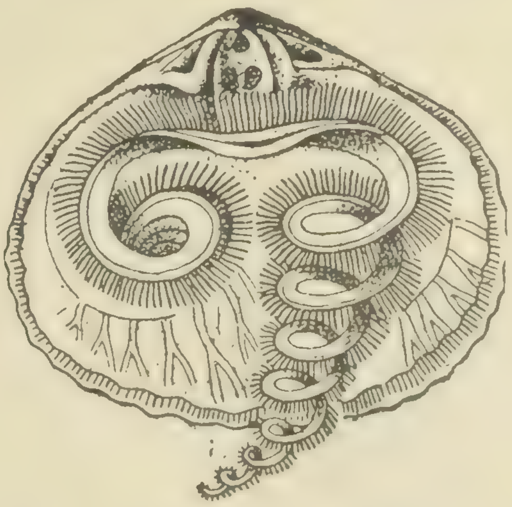


FIG. 144. — *Hemithyris psittacea*, with arm extended.

The ability of the brachiopods to form calcareous supports for the brachia may be regarded as degenerate in living species. Among extinct species, especially those belonging to the later Palæzoic and earlier Mesozoic eras, are to be found delicate and often exceedingly complicated supports, which were probably continuous with the fleshy arms for the entire extent of the latter. In SPIRIFER, for example, long spiral cones consisting of many revolutions of an exceedingly tenuous calcareous ribbon are frequently preserved with the utmost delicacy, and in KAYSERIA. AMPHICLINA and some forms of ATHYRIS from the St. Cassian beds, these spirals are accompanied by an accessory pair, making four in all. The mode of union of these parts, their attachment to the valves and to the various supporting septa, are features of much significance, while the delicacy of such structures renders the determination of these points of great intricacy and difficulty.

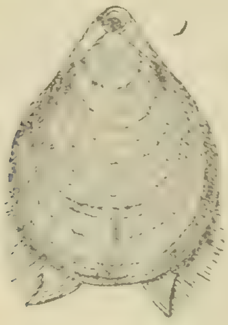


FIG. 145.-*Terebratulina caput-serpentis*, with arms extended. (BARRETT.)

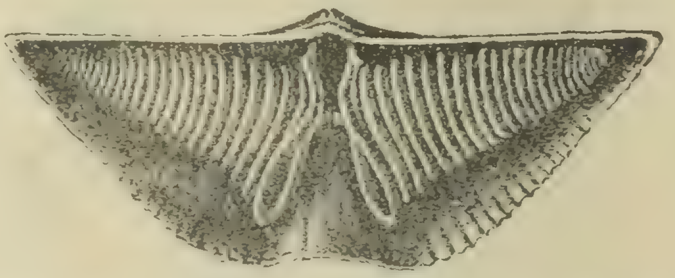


FIG. 146.—*Spirifer mucronatus*. Interior of brachial valve, showing spirals.

Such calcareous supports, which in any individual are known as the *brachiaium*, are formed by the interlocking and cementation of the spicules which are disseminatedthrough the canals and cirri of the brachia. The recent brachio pods possess only simple lamellar extensions which, in TEREBRATELLA, MAGELLANIA, LIOTHYRINA and TEREBRATULINA consist of two lateral processes. These may be united at their anterior extremity (LIOTHYRINA. TEREBRATULINA), or reflexed anteriorly, the union of the branches being median or posterior (MAGELLANIA, TEREBRATELLA.

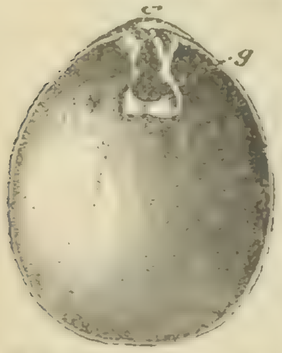


FIG 14[illegible]. Interior of brachial valve of *Liothyrina vitrea*. *c'*. cardinal process: *g*. brachial supports. (DAVIDSON.)

In all these cases the simple apparatus corresponds to only a portion of the first revolution of the ribbon in SPIRIFER, RHYNCHOSPIRA, etc.

The size of the spiral cones and their direction varies to a certain degree equably with the form of the interior cavity of the valves. In species of Spirifer with greatly extended hinge-line the cones are very long and are directed toward the cardinal angles; where the hinge is short (Martinia) and its lateral angles rounded the cones are short or placed at oblique angles. In Merista, Athyris, Rhynchospira, Meristina, etc., etc., the axis of the spirals lies in the greatest transverse diameter of the shell. In Atrypa the two flattened cones lie side by side, and their apices are directed into the cavity of the deep brachial valve.

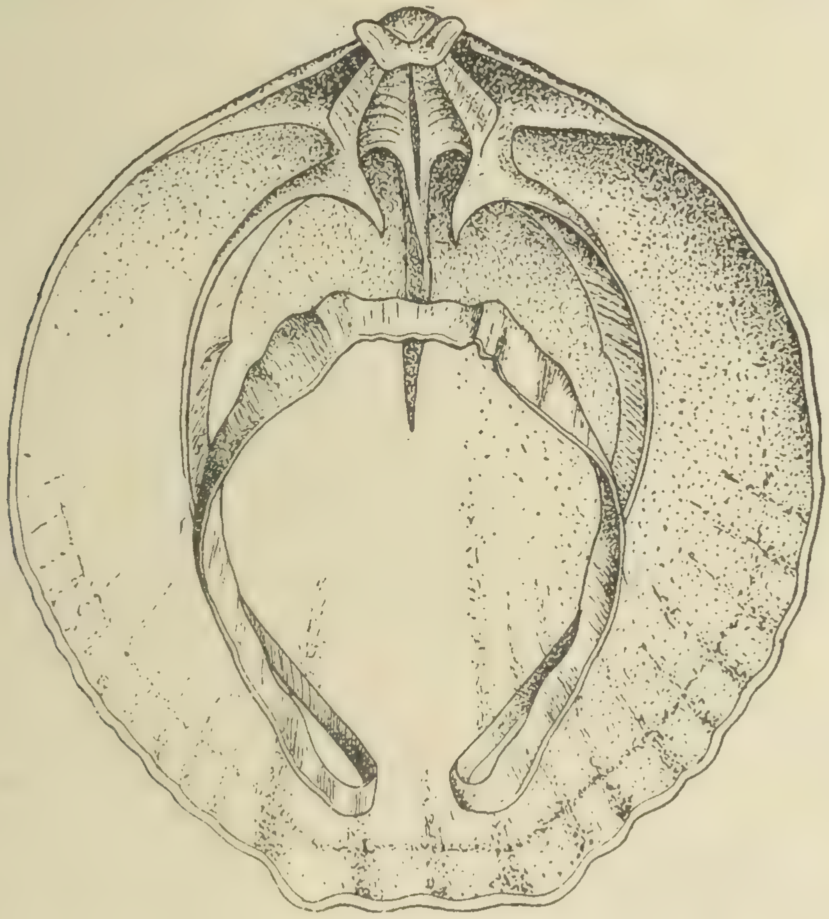


Fig. 148.—The brachial supports of *Magellania australis*. (Hancock.)

The brachial supports are attached to the hinge-plate, or apical portion of the brachial valve, by two processes termed *crura*. The precise termination of the crura and the commencement of the spiral ribbon is often obscure, but is frequently indicated by a sharp angle at the point of union and an abrupt widening of the ribbon directly behind it. (Nucleospira, Rhynchospira.) From this the curvature of the ribbon is downward into the cavity of the brachial valve, and the extensions of the ribbon for the first one-half revolution are termed the *primary lamellæ*.

In Spirifer the crura are very long, the bases of the spiral cones in this genus being small and situated well forward. The primary lamellæ are usually broader and stronger than the remainder of the coil and may be preserved in the fossil state when the rest is lost. These lamellæ, near the middle of their length, give off a pair of simple laminar processes which extend upward between the bases of the cones, and usually unite. When these processes thus unite the body formed is termed the *jugum;** when they do not unite, as in SPIRIFER, they may be called the *jugal processes.*

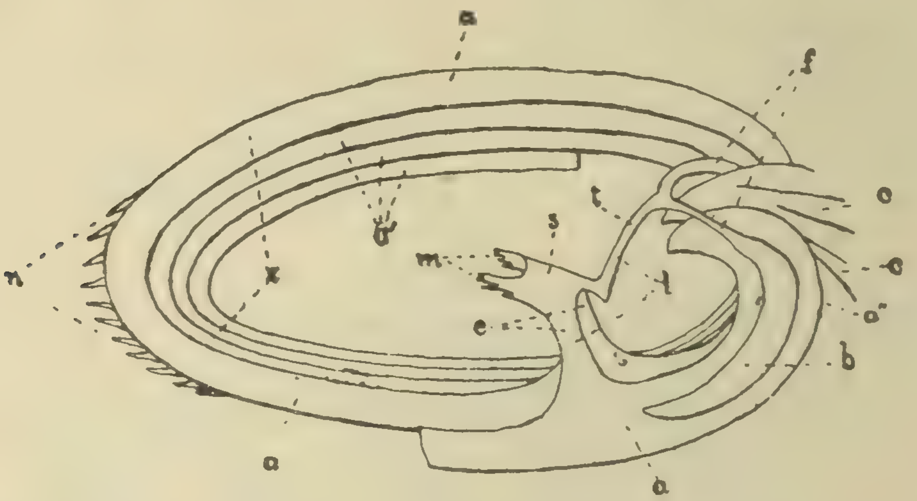


FIG. 149.— Diagram of loop and spiral *Athyris*; *x*, spiral; *a*, primary lamellæ; *a'*, secondary lamellæ; *a''*, umbonal blades; *c*, crura; *l*, jugum; *e*, lateral branches of jugum; *s*, saddle; *m*, fimbriated extremity; *t*, stem of jugum; *f*, branches of jugum; *b*, intercalary lamellæ; *n*, fimbriæ on outer edges of spiral.

The function of this jugum is, unquestionably, in part to strengthen the entire apparatus and resist the strains to which the cones are exposed from gravitation and other causes. It is therefore remarkable that SPIRIFER, in which the cones reach

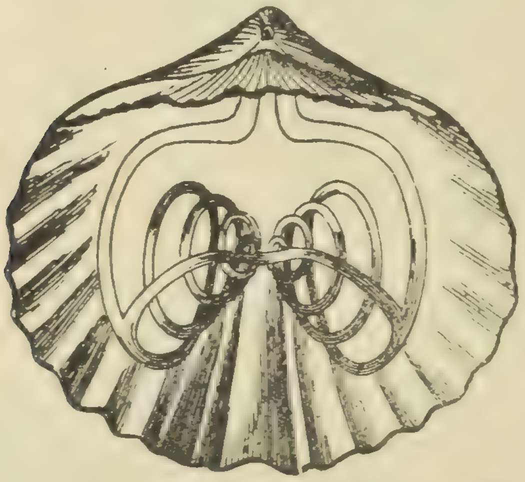


FIG. 150.— *Zygospira modesta.* The brachidium exposed by the removal of the brachial valve, showing the jugum.

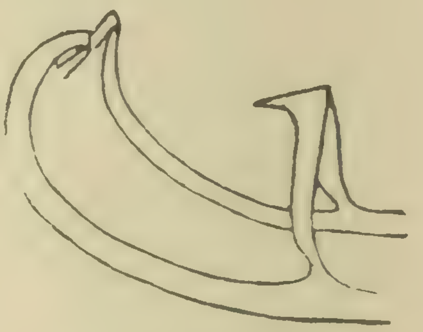


FIG 151.—Jugum of *Trematospira multistriata*, attached to a portion of the primary lamellæ.

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* This organ has usually been termed the *loop*, but the use of this term among the brachiopods with calcified spirals causes obscurity and confusion, as the word was originally applied to the entire brachial support in the terebratuloids, and it must continue to be used with this meaning while the relations of the true *loop* to the *jugum* of spire-bearing shells is that of a whole to a part.

their greatest development, is always devoid of this support, and equally noteworthy that this genus, which seems poorly adjusted against such strains when compared with other spire-bearing genera, should have maintained so long and so prolific a development without variation in this respect.

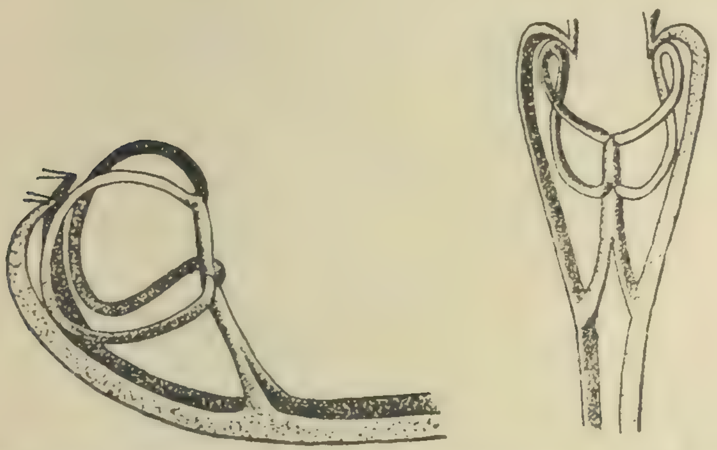


Fig. 152.—Jugum of *Meristella arcuata*.

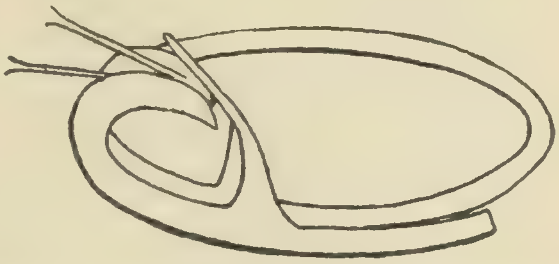


Fig. 153.—Jugum of *Nucleospira ventricosa*.

The jugum does not end at the point of union of the two lateral jugal processes, but is more or less continued, in its simplest form, into a short, straight stem, inclined backward and terminating in an acute angle (Retzia, Rhynchospira, Whitfieldella); in Bifida this stem is long and extends to the inner surface of the pedicle-valve where its extremity is inserted into a deep groove in the shell. In Eumetria and Meristina the

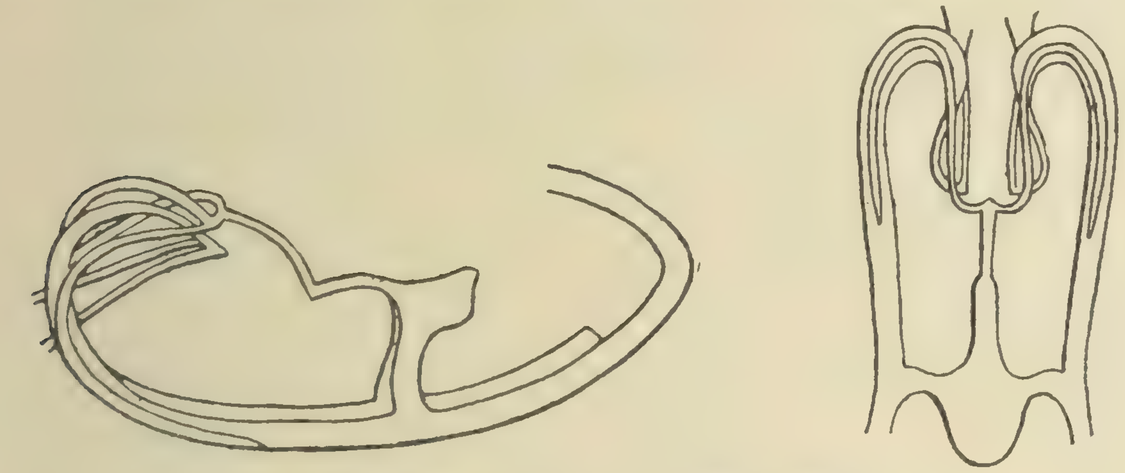
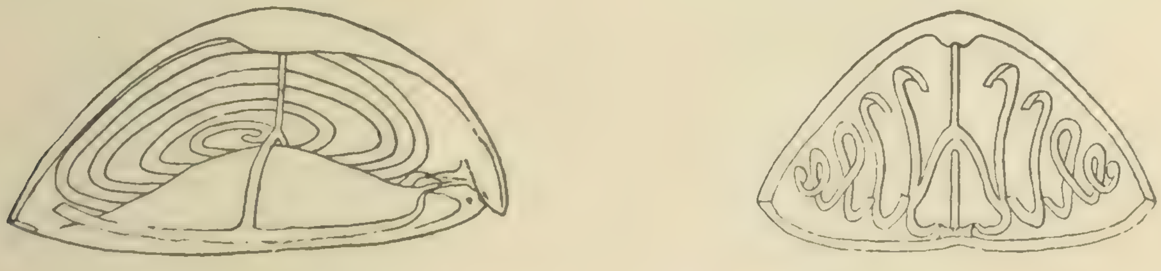


Fig. 154.—Jugum of *Athyris vittata*.



Brachial apparatus of *Bifida lepida*.

Fig. 155.—Longitudinal section. **Fig. 156.**—Transverse section.

extremity of the stem is bifurcate, but the terminal processes do not extend beyond the ends of the crura; while in Athyris, Tetractinella and Amphitomella they are continued backward between the primary and secondary lamellæ for about one fourth of a revolution. In Pexidella the intercalary lamellæ are still longer; in Amphitomella, Kayseria and Amphiclina they are continued for the entire length of the spiral cones thus making a double spiral on each side. In Merista and Meristella the

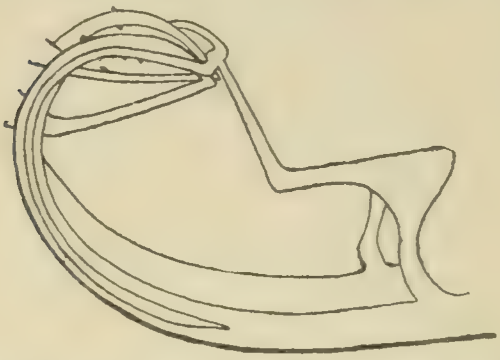


FIG. 157.—Jugum of *Athyris spiriferoides.*

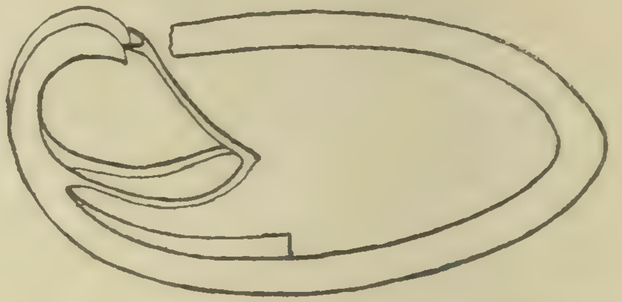


FIG. 158.—Jugum of *Eumetria Verneuiliana.*

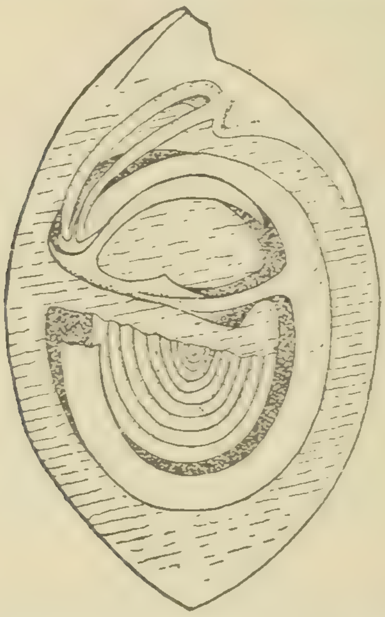


FIG. 159.—Loop of *Tetractinella.* (BITTNER.)

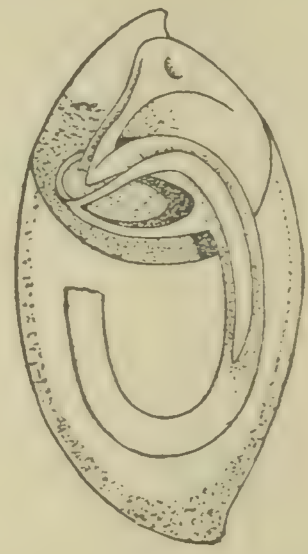


FIG. 160.—Loop of *Amphitomella.* (BITTNER.)

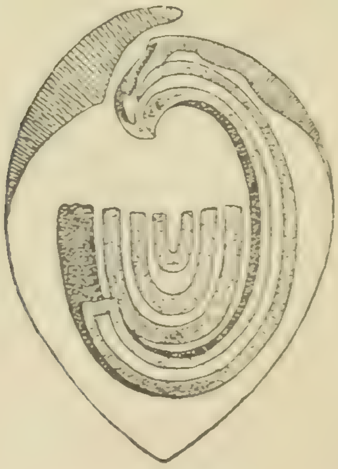


FIG. 161.—Loop of *Pexidella.* (BITTNER.)

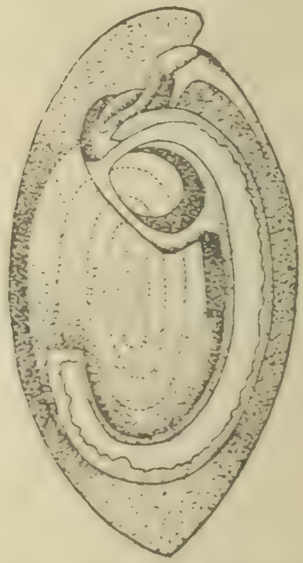


FIG. 162.—Loop of *Diplospirella.* (BITTNER.)

divisions of the stem of the jugum, or intercalary lamellæ, are short, recurving and joining the lateral processes near their union.

This place of union of the lateral branches of the jugum is frequently somewhat thickened and expanded (RETZIA, RHYNCHOSPIRA, UNCITES) and in ATHYRIS it is a broad, saddle-shaped structure.

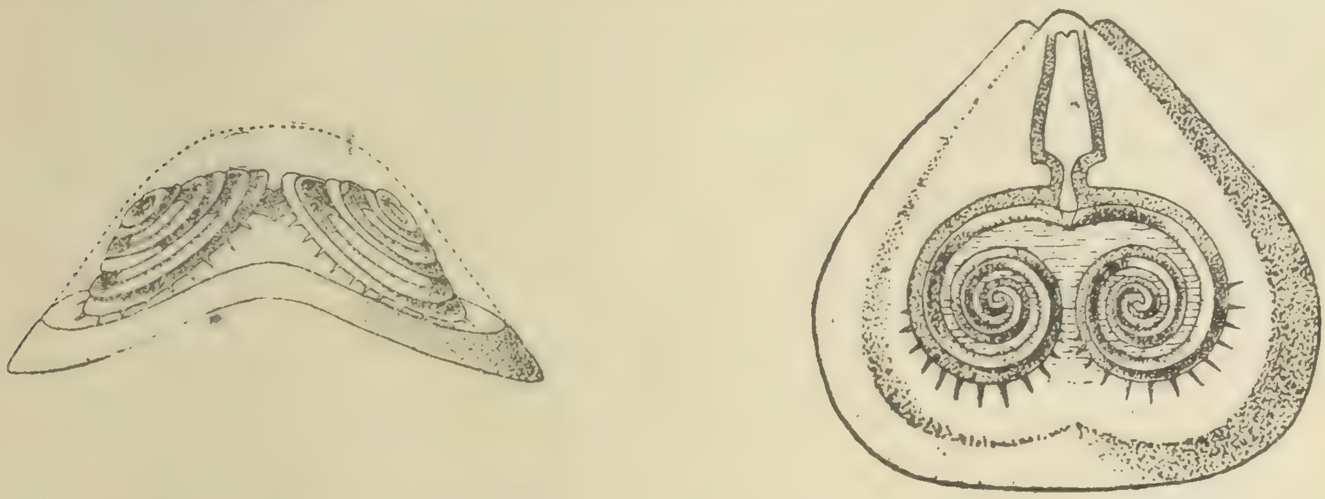


FIG. 163.—Brachial apparatus of *Koninckina*, showing the double spirals. (BITTNER.)

In the last genus the posterior margin of this *saddle* is sometimes fimbriated, and not infrequently similar fimbriæ or spinules are retained on the outer posterior edges of the primary and secondary lamellæ; these have also been observed in ATRYPA, AMBOCOELIA, DAYIA, etc. These spinules undoubtedly result from the network of spicules deposited in the cirri of the brachia.

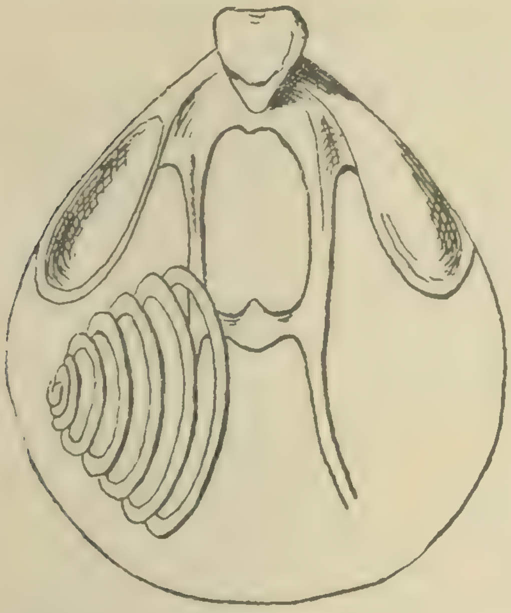


FIG. 164.—Loop and spiral of *Uncites gryphus*. (DAVIDSON.)

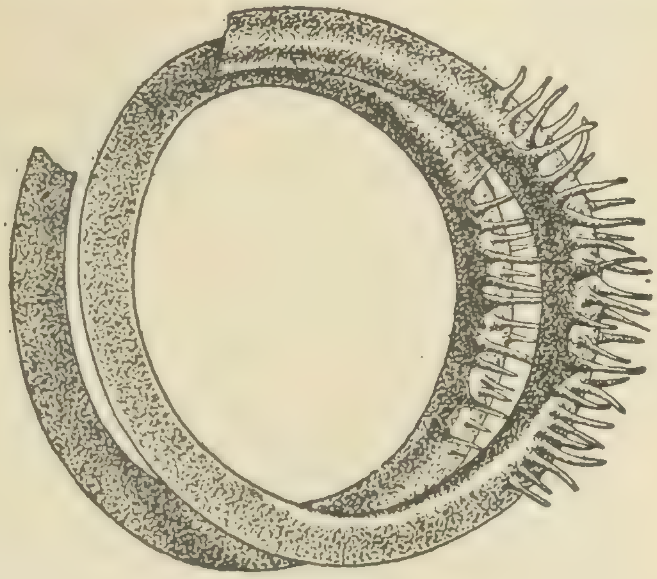


FIG. 165.—Portion of spiral of *Spiriferina rostrata*, showing the fimbriæ on the outer margins of the coils. (DAVIDSON.)

The jugum is often in close relation with the median septum of the brachial valve. Perhaps in no case among the spire-bearing species is there an actual union of these parts, such as is so frequent among the terebratuloids; but in several genera, MERISTINA, KAYSERIA, BIFIDA, a high median septum rises so close to the angle of the jugum that but a very slight depression of the entire brachial apparatus would cause it to rest upon the septum and thus secure an efficient support. Whether this septum has been at all concerned in the modifications to which the spirals have been subjected in growth has yet to be determined. In genera, where the spirals are convergent rather than divergent, ATRYPA, ZYGOSPIRA, GLASSIA etc., the jugum is always simple in

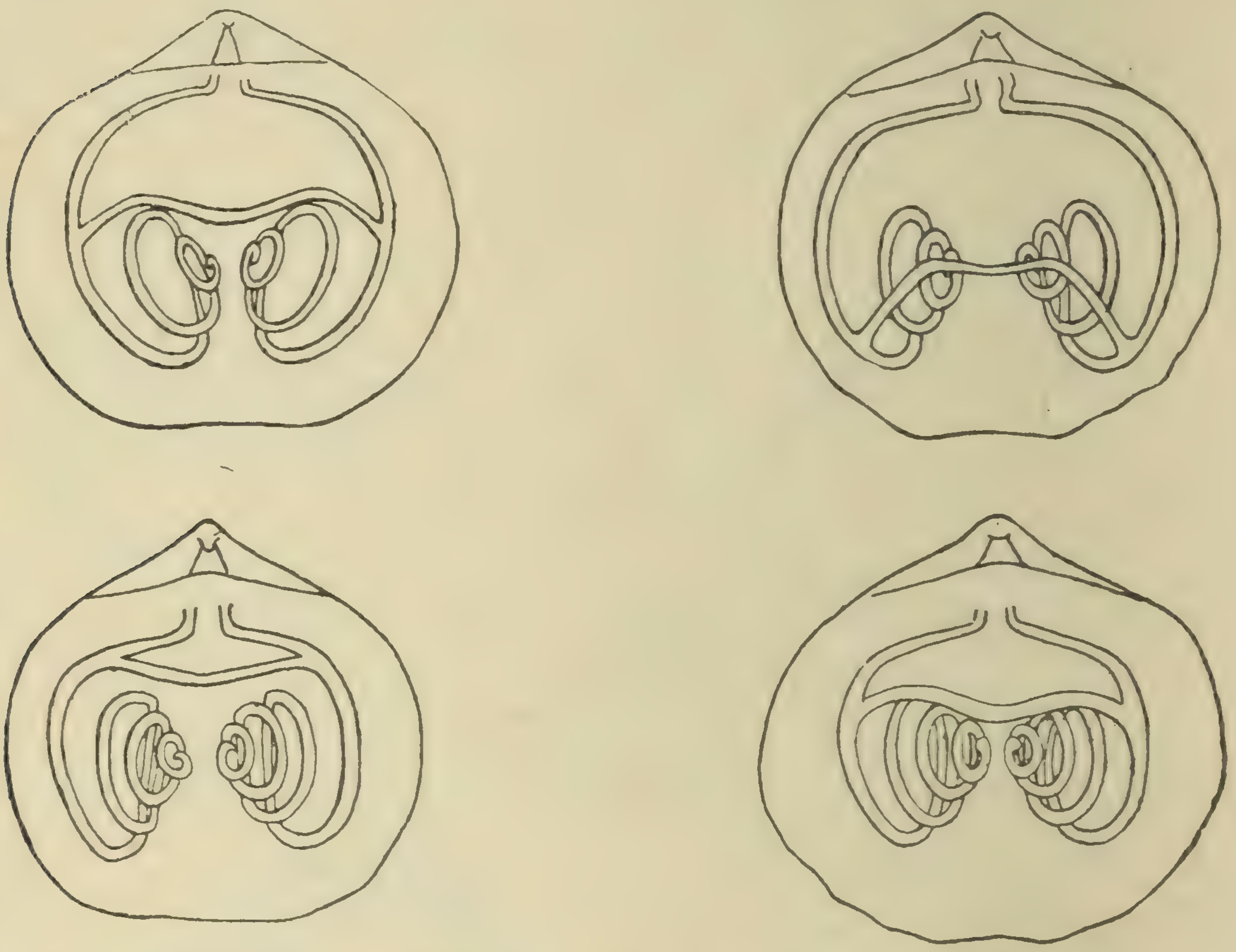


FIG. 166.— Brachial apparatus of *Zygospira modesta*, showing the variation in the position of the jugum.

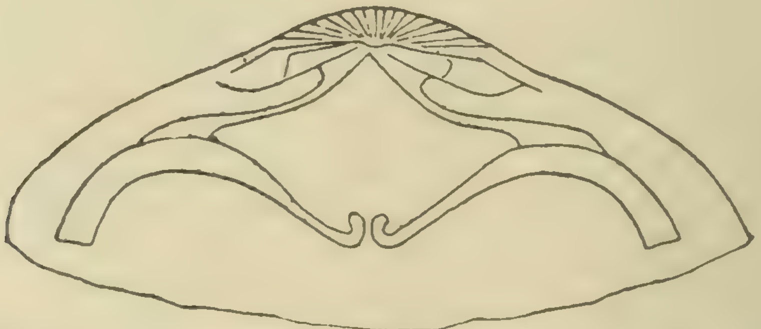


FIG. 167.— Jugal processes of an adult *Atrypa reticularis*.

its structure. ATRYPA, with its spirals directed upward into the cavity of the brachial valve, has its jugum situated posteriorly and is composed of two lateral branches directed anteriorly, and slightly upward in the middle. In early growth-stages this is a continuous band, but in mature or senile conditions of growth it becomes divided in the middle (probably from the lateral strains to which it is subjected) and the extremities of the jugal processes become much thickened. In GLASSIA the spirals have their apices at the center of the internal cavity and their bases at the sides; the jugum is a short posterior transverse band. In ZYGOSPIRA the variation in the position of the jugum in a given species (e. g., *Z. modesta*) is remarkable, it being sometimes posterior, at

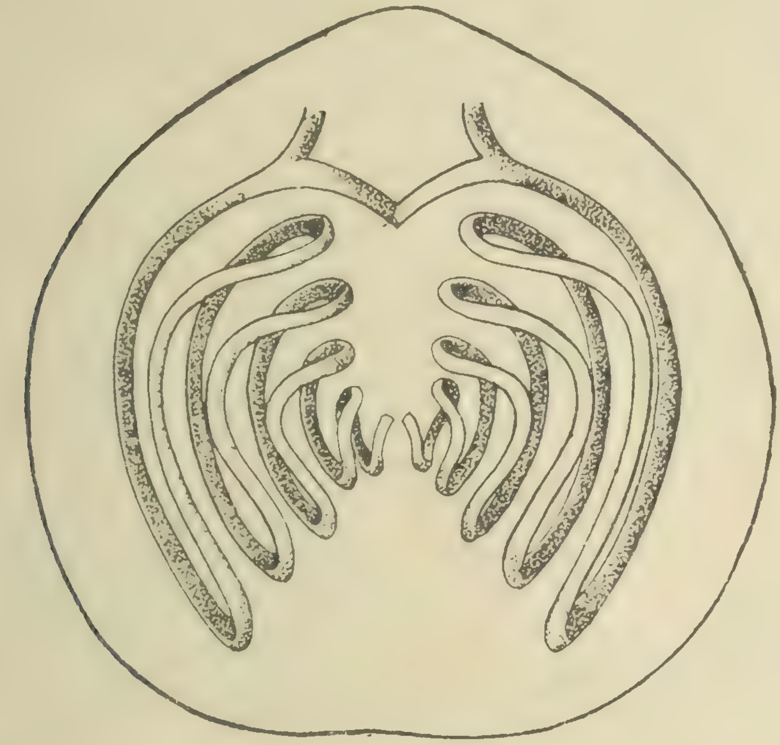


FIG. 168.— Brachidium of *Glassia obovata*, showing the posterior position of the loop. (DAVIDSON.)

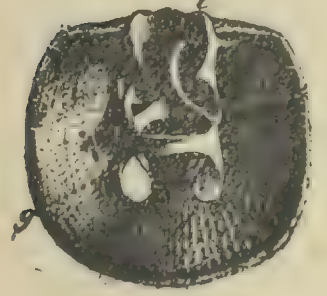


FIG. 169.— Brachial valve of *Megerlia truncata*. *g*, loop; *l*, septum. (DAVIDSON.)

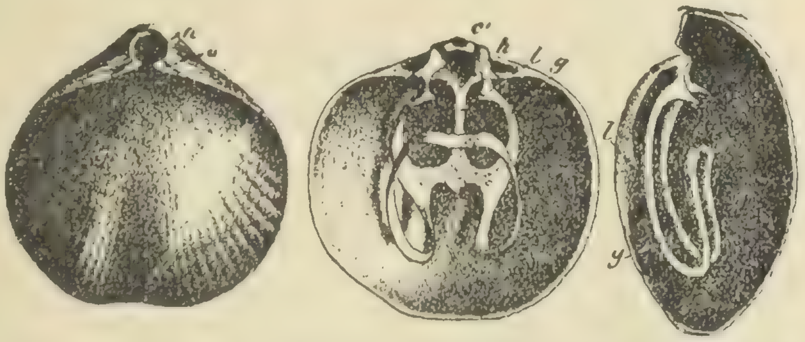


FIG. 170.— *Terebratella dorsata*. *n*, foramen; *o*, deltidial plates; *c'*, cardinal process; *h*, hinge-plate; *l*, septum; *g*, brachial supports. (SUESS.)

others median, and again anterior, curving forward in the first case and backward in the last.

In the non-spiriferous brachiopods, or those in which the brachial apparatus is abbreviated, we usually find a simple representation of the primary lamellæ and the jugum which may be variously complicated with the median septum of the brachial valve. In this group the entire calcified apparatus is termed the *loop*, which is typically composed of two long or short primary or *descending lamellæ* which may recurve more or less profoundly at their anterior extremity (*ascending lamellæ*,) and unite in a transverse band. This last is the homologue of the jugum. In TEREBRATELLA, TEREBRATALIA, MÜHLFELDTIA, ISMENIA, and some other genera, the descending lamellæ are united to the median septum by a dorsal band, which is a residuum resulting from progressive resorption of the calcareous parts, and wholly disappears in more advanced forms, such as *Magellania venosa*. In typical forms of MAGELLANIA the septum also has disappeared and the loop in the adult condition is without any evidence of former connection with the valve, except at the hinge-plate. A corresponding adult condition is found in the palæozoic genera CRYPTONELLA, MEGALANTERIS DIELASMA, etc. In CENTRONELLA and RENSSELAERIA the primary lamellæ simply unite at their anterior extremities without reflection, the apparatus here being expanded into a triangular plate. A somewhat similar arrangement is seen in MAGAS and PLATIDIA, while in BOUCHARDIA, KRAUSSINA, little is left of the brachial sup-

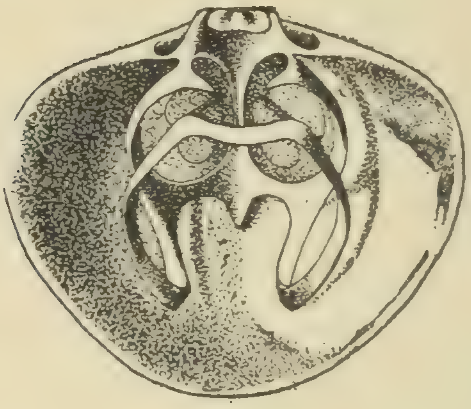


FIG. 171.— *Terebratalia dorsata*. (WOODWARD.)

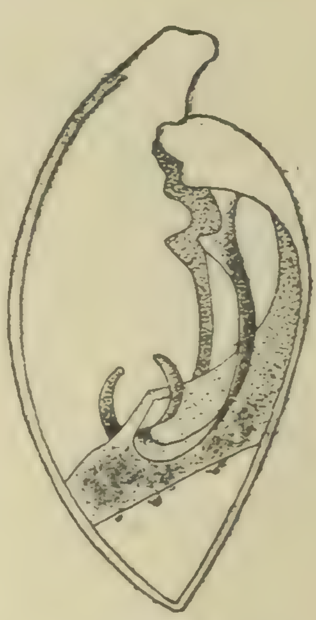


FIG. 172.— *Magasella Cumingi*. (DAVIDSON.)

ports but the median septum and the portions of the loop attached to its anterior extremity.

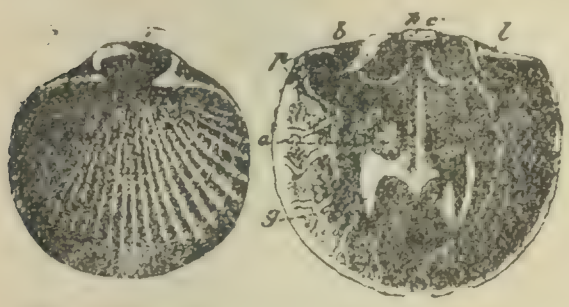


FIG. 173.— *Kraussina rubra.* *n*, foramen; *hc*,′ cardinal process; *a*, *b*, adductors; *p*, pallial sinuses; *g*, brachial supports; *l*, septum. (DAVIDSON.)

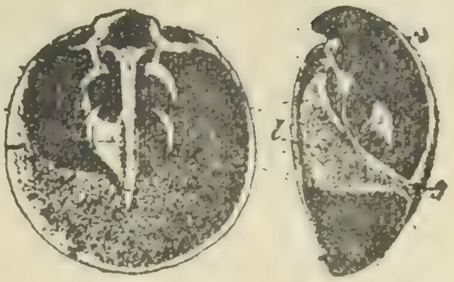


FIG. 174. — *Magas pumilus.* *b*, median septum; *g*, brachial supports. (DAVIDSON.)

Of Palæozoic genera TROPIDOLEPTUS alone has afforded evidence of actual connection in the mature state of the descending lamellæ with the median septum, a condition of the brachial apparatus comparable to that of PLATIDIA among living forms.

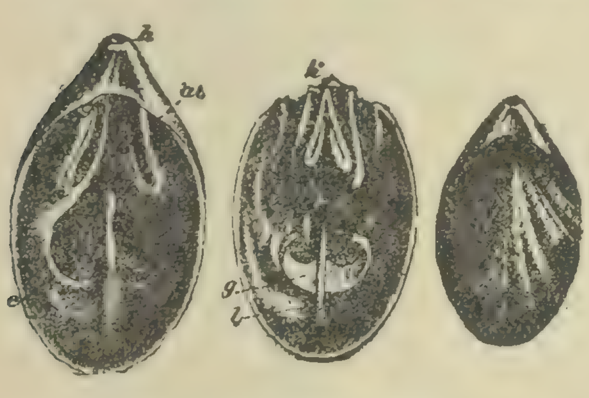


FIG. 175.— *Bouchardia rosea.* *h*, foramen; *ab*, adductors; *e*, diductors; *k*, cardinal process; *g*, brachial supports; *l*, septum.

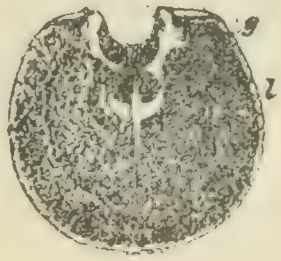


FIG. 176. — Brachial valve of *Platydia anomioides.* *g*, loop; *l*, median septum. (DAVIDSON.)

In many of the terebratuloids the union of the crura and primary lamellæ is represented by sharp crural angles directed inwardly. In LIOTHYRINA, which has the entire supporting apparatus remarkably abbreviated, these angles are conspicuous, while in TEREBRATULINA they unite to form a continuous band. In the Devonian genus STRINGOCEPHALUS, the crura are very long, the loop absent, and the lamella very broad and situated just within the margin of the brachial valve; from it extends a series of filamentous processes, which are directed towards, and may have been attached to the crura.

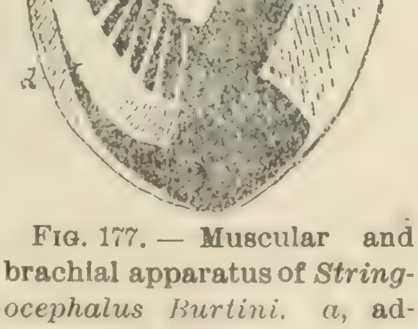


FIG. 177. — Muscular and brachial apparatus of *Stringocephalus Burtini.* *a*, adductors; *b*, diductors; *c*, cardinal process; *d*, brachial support. (HOERNES.)

The species in which the lower surface of the brachia is attached to the mantle, have a simple vertical lamella (CISTELLA), which may be lobed (MEGATHYRIS, BACTRYNIUM, EUDESELLA, DAVIDSONELLA, etc.). In THECIDIUM, THECIDELLA, LACAZELLA, etc., the definition of the lamella is obscured, the spicular network being loose and sponge-like. The brachiopods which were not possessed of elaborate brachial supports may have long calcareous crura, as in RHYNCHONELLA and its allies, or even these may be wanting, as in STROPHOMENA, PLECTAMBONITES and PRODUCTUS. Such shells, however, sometimes retain grooved impressions made by the spiral arms upon the inner surface of the valves (DAVIDSONIA, RAFINESQUINA) In CHONETES and PRODUCTUS there are two divergent impressions on the brachial valve, which are commonly known as the *reniform markings*. and these are generally regarded as due to the brachia, though their precise relation to these organs has not been satisfactorily explained.

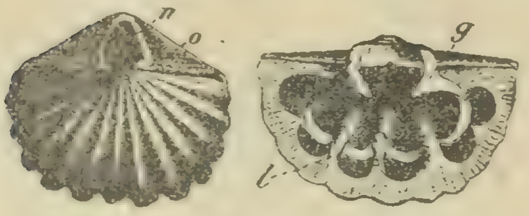


FIG. 178. — *Megathyris decollata*. *n*, foramen; *o*, deltidial plates; *g*, crura; *l*, lobed extension of brachial supports. (BRONN.)

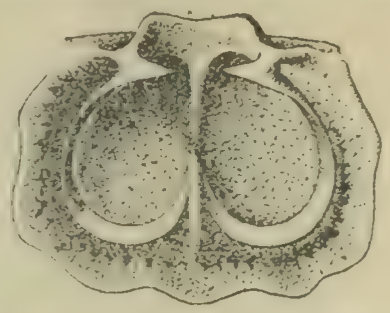


FIG. 179. — *Cistella neapolitana*. Interior of brachia-valve. (WOODWARD.)

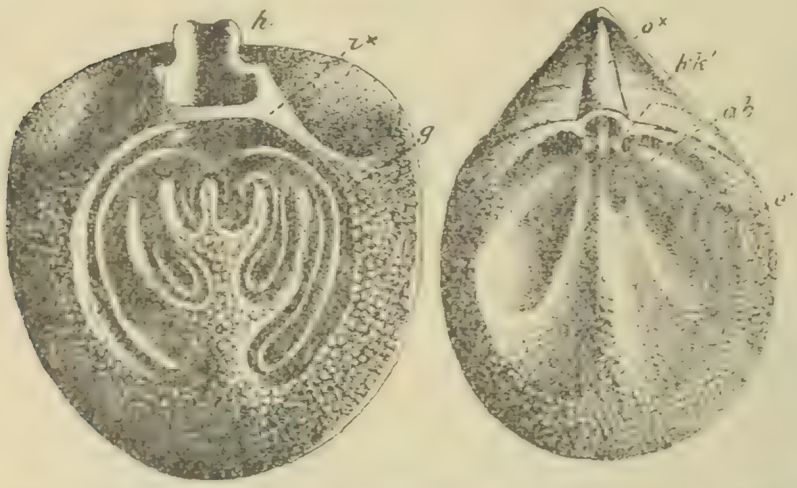


FIG. 180.— Interior of brachial and pedicle valves of *Thecidium radiatum*. *o'*, deltidium: *kk'*. teeth; *ab*, adductors; *e'*, diductors; *h*, cardinal process; *i'*, cardinal plate; *g*, brachial supports. (SUESS.)

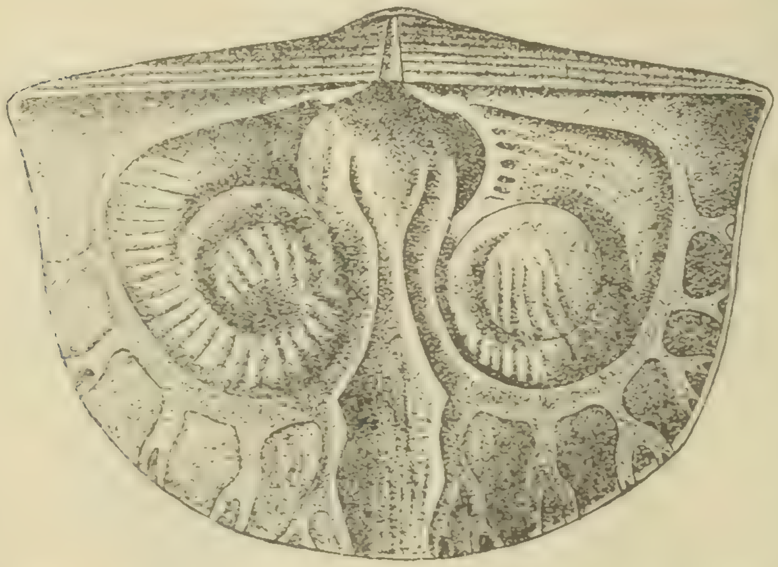
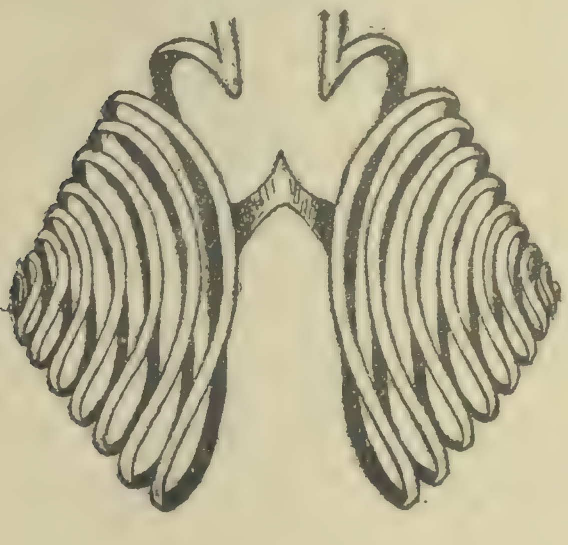
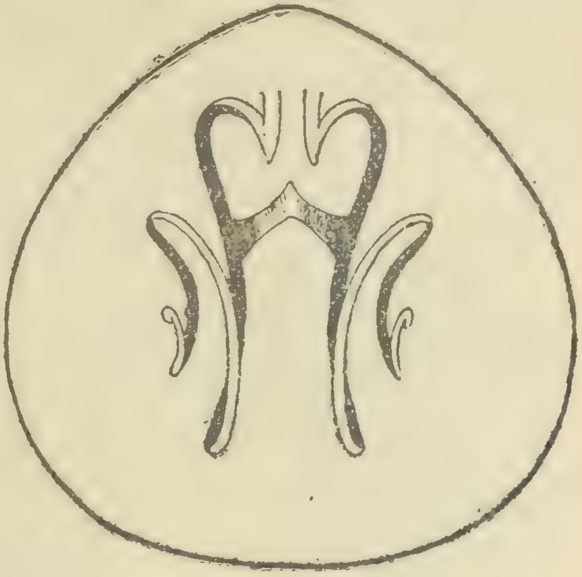


FIG. 181. — The interior of the pedicle-valve of *Rafinesquina Jukesi*, showing the impression of the spiral arms. (DAVIDSON.)

Upon the mode of development and growth of the brachia and supporting apparatus some important observations have been made.

MORSE has shown that in early stages of TEREBRATULINA the arms are simple or double horse-shoeshaped processes, quite like the lophophore of the Bryozoa. The same author also demonstrates that the formation of the crura and brachial supports is a gradual and permanent accretion, growth taking place on both sides until union is effected and the support thus completed.

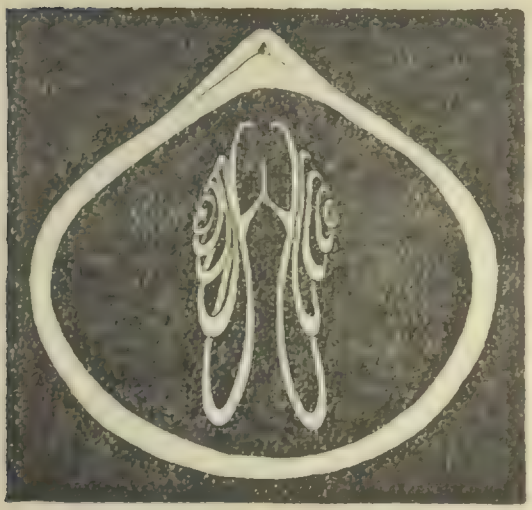


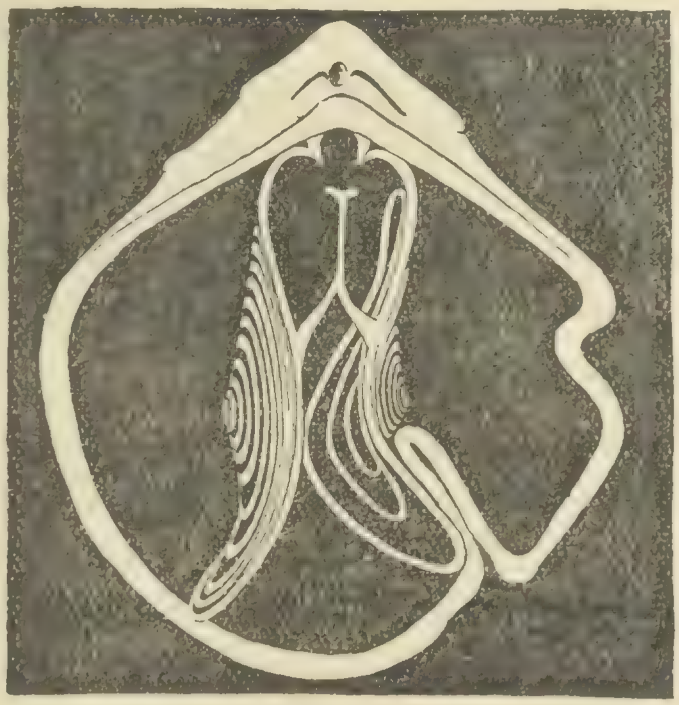


Rhynchospira (Homœospira) evax.

FIG. 182.—The mature condition of the brachidium.

FIG. 183—The brachidium in a very early stage of growth; in this figure the form of the jugum is wholly constructive. (BEECHER and CLARKE.)





Meristina Maria.

FIG 184.—The brachidium in a very early condition of growth; showing the lax revolutions of the ribbon and the depressed spiral cones.

FIG. 185.—The brachidium in a young shell, showing a distortion in one of the spirals caused by an obstruction to the peripheral growth on one side of the valves, which has apparently produced no disturbance of function in the brachia.

Among the spire-bearing forms it has been shown that in the young of *Rhynchospira* (*Homœospira*) *evax* the ribbon is very slender and makes but a few and very lax revolutions. The same fact is evident in the young of *Meristina Maria* (as shown in the accompanying figures), where the revolutions are few and the spiral cones depressed. The growth of these solid bodies and the increase in number of the revolutions could be effected only by constant resorption and redeposition of the spicular calcareous secretions from the brachia.

Kovalevski, Friele, Deslongchamps, Œhlert, Beecher and others have given accounts of the development of the brachia in Cistella and some of the higher genera of the *Terebratellidæ* (Terebratella, Magellania, Macandrevia, Dallina, Terebratalia). In the early stages of such shells the brachia have the form of a circlet, extending forward from about the mouth, bearing a few tentacles or cirri, which are directed inwards. This condition is comparable to the adult condition in Gwynia and has therefore been termed the *gwyniform stage*. By the development of a median septum in a succeeding stage of growth this circlet becomes inflected medially and the resultant condition is that of the adult Cistella (*cistelliform stage*). With the further growth of the septum and the development of its lateral processes the brachia gradually take on the form of the mature Platidia (*platidiform stage*), the cirri finally becoming everted, and the median unpaired arm resulting from the continued growth of the basal cartilage and the multiplication of the cirri at the distal extremities of the brachia.

These developmental stages are still more clearly exemplified in the formation of the loop or calcareous supports. Among the *Terebratellidæ* there is one group of boreal forms (*Dallininæ*) and one also of austral forms (*Magellaninæ*), all agreeing in having the loop, in its final condition, composed of long descending and ascending branches in no connection with the median septum. In the boreal forms (Macandrevia, Dallina) the development of the loop has passed through a series of stages corresponding successively with the adult condition in Platidia, Ismenia, Mühlfeldtia and Terebratalia, while in the austral group (Magellania) the preliminary stages are reproduced in the adult Kraussina, Bouchardia, Megerlina, Magas, Magasella and Terebratella, successively. The larval conditions of the terminal members of both series are similar to the adult condition of the simplest members of the family, Cistella and Gwynia.

Thus similar resultants have ensued in this family by progressive growth and resorption of the brachial supports through quite dissimilar lines of development.*

From the study of young stages in a Carboniferous species, *Dielasma turgida*, a terebratuloid with short, recurved loop, and in the Silurian species, *Zygospira recurvirostra*, a spire-bearing shell with introverted cones, it has been demonstrated† that in the earliest observed conditions of both, the brachidium consists simply of the two lateral or descending lamellæ, united in front, forming an expanded triangular plate like that in Centronella and Rensselaeria.

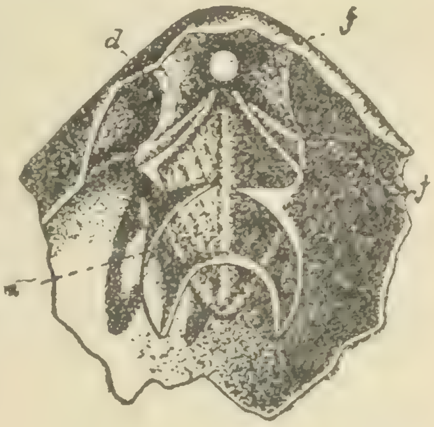


Fig. 186.—*Dielasma elongatum* *f*, foramen; *j*, jugal processes; *d*, dental plates; *m*, muscular impression.—(Davidson.)

Resorption of the anterior portion of this plate gradually produces the ascending and transverse lamellæ of Dielasma and the jugum of Zygospira; parts which are thus seen to be alike in origin and function. With Dielasma the process here ceases, but in Zygospira there is a continuation of the lamellæ carried forward from the ante-lateral angles of the loop, which, with growth takes on the spiral form of the mature brachia. The inference from this evidence is that the Centronella-loop is of the simplest type; anything more elementary would represent the condition of the descrete crural processes in Rhynchonella. The recurved loop of the terebratelloids is a more advanced condition of this organ, while the spiral brachidium, attained so abundantly and with such diversity, during Paleozoic and early Mesozoic time, represents its most elaborate development.

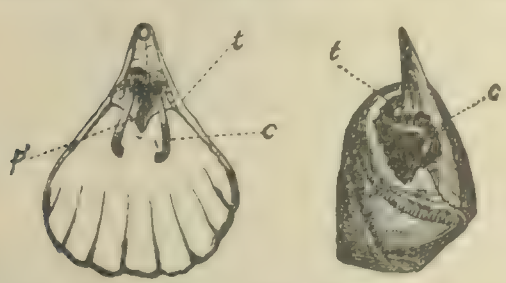


Fig. 187.—*Rhynchotreta cuneata*; showing the crural processes.

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* These interesting facts have been established by the investigations of Friele, Œhlert, Fischer and C. E. Beecher.

† Beecher and Schuchert; Proceedings of the Biological Society of Washington, vol. VIII, 1893.

THE NERVOUS SYSTEM.

The nerve-collar surrounding the œsophagus constitutes the principal nerve mass in the Brachiopoda. In the articulate species there is a large ganglion (subœsophagian) on one side of

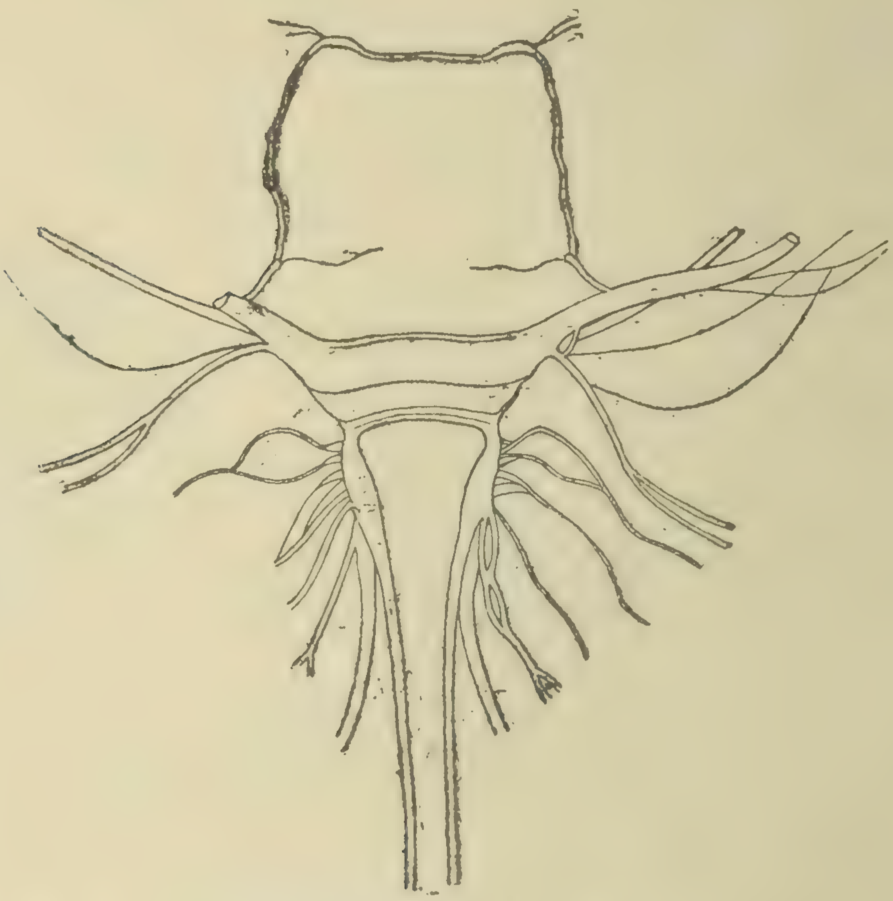

FIG. 188.— Œsophageal ganglion of *Magellania cranium*. (HANCOCK.)

the œsophagus, connected by fine lateral commissures with a smaller ganglion on the opposite side. In the inarticulates (LINGULA, CRANIA) so far as ascertained, the upper and lower ganglia are not so well developed, the nerve-ring being of more equal size throughout. From the swellings of the œsophageal rings, nerve-fibers are given off to the brachia, muscles, and the two lobes of the mantle. It would appear that the nervous system as a whole is more highly developed in the articulate than in the inarticulate brachiopods. It has not been demonstrated that the adult

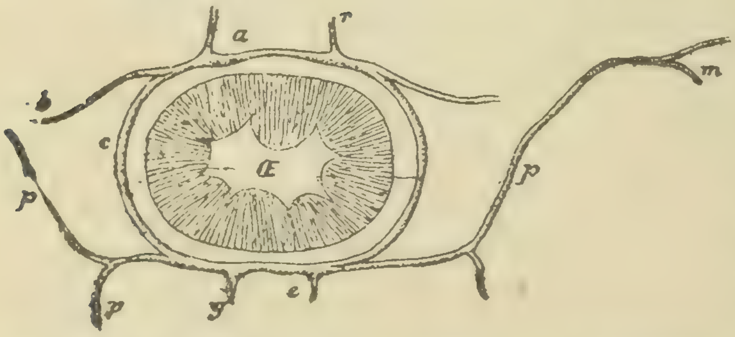

FIG. 189.— Nervous system of *Crania*. Œ, œsophagus in section; *c*, collar; *a*, cerebroid ganglion; *n*, brachial nerve; *e*, subœsophageal ganglion; *g*, inferior nerve; *p*, dorsal pallial nerve; *p*. ventral pallial nerve; *m*, nerve of muscles. (JOUBIN.)

brachiopod possesses any *organs of special sense*, but in the embryos of several genera, bodies believed to perform such functions have been observed.

BROOKS has shown the existence of an auditory organ in *Lingula*, similar to that of the lamellibranchs, viz.: a pair of otocysts containing vibratile otoliths, which are situated close to the nerve collar.

Similar structures were observed in DISCINISCA by MÜLLER. The very young of THECIDIUM, CISTELLA and DISCINISCA bear two or four minute pigment spots on the cephalic segment, which are believed to be organs of vision. All trace of these sense organs is resorbed in later growth.

THE REPRODUCTIVE SYSTEM.

It has already been observed that the brachiopods, so far as known, not only reproduce by ova, but are also diœcious. It is difficult, however, to distinguish the male from the female animal, except upon the approach of fecundity. Then the testes become enlarged by the colorless spermatic fluid, and take on a pale hue; on the other hand, as the ovaries of the female become crowded

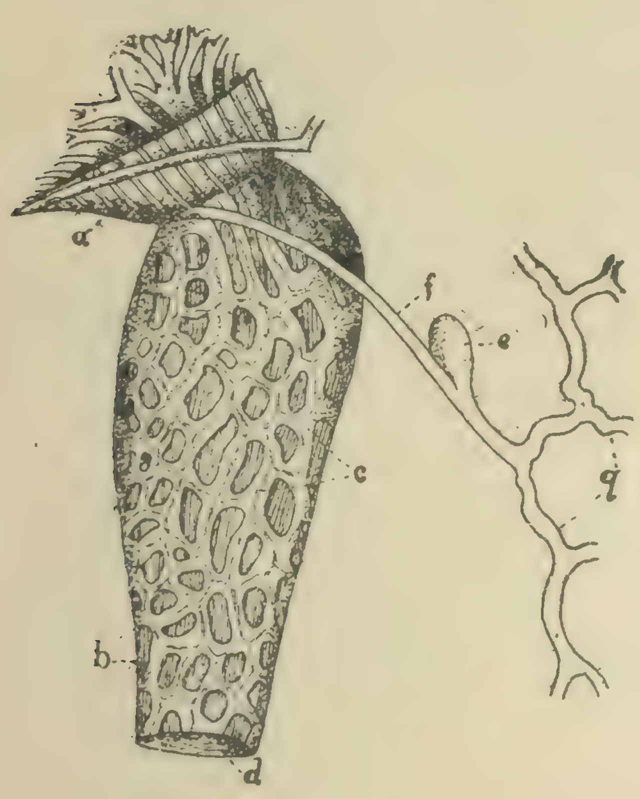

FIG. 190.— Oviduct of *Hemithyris psittacea*, *a*, laminated portion; *b*, tubular portion; *c*, wrinkles of lining membrane; *d*, external opening; *e*, vescicle; *f*, *g*, blood-vessels. (HANCOCK.)

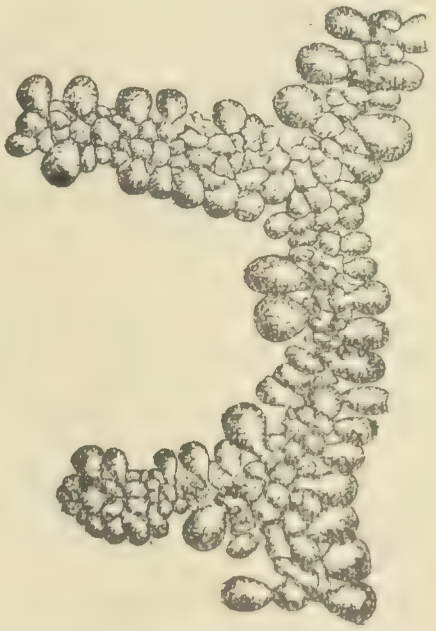

FIG. 191.—Fragment of ovary of CRANIA. (JOUBIN.)

with eggs, the slight color of the latter deepens the tint of the entire organ.

The location of both male and female reproductive glands is essentially the same. Generally they are found to occupy the main trunks of the vascular sinuses though they may extend into the visceral chamber, and, in some of the inarticulate genera (LINGULA, DISCINISCA), be restricted to the latter. When in the pallial sinuses, though attached to the upper and inner wall of the mantle, they frequently leave a lobed or pitted impression upon the shell, which is retained after the shell is fossilized.

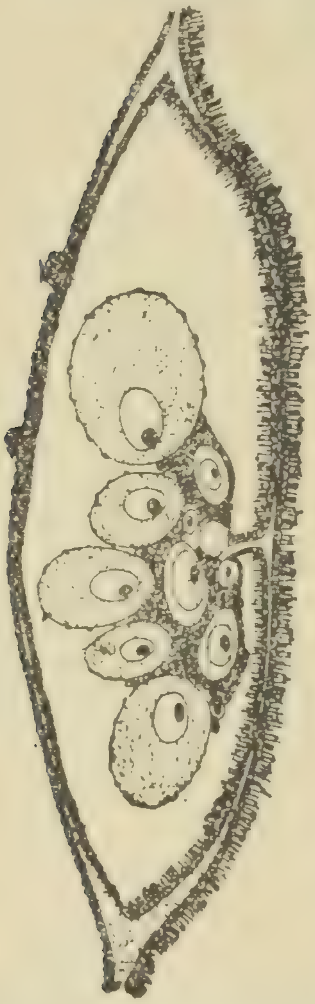

FIG. 192.— Section of ovary of *Crania*, showing the suspended ova in various conditions of development. (JOUBIN.)

The discharge of the genital products is effected by two or four tubular organs or funnels, which have been described by some authors (OWEN) as hearts. These trasverse the wall of the perivisceral chamber and open outward into the pallial cavity. Their inner openings are large, expanded orifices, abundantly plaited, and separated by a constriction from the narrower part. Ova have been seen to pass through these organs (MORSE) to which they are drawn by the action of the cilia covering their surface. HUXLEY considers that these funnels also subserve the function of renal organs and that they are homologous to the *organs of Bojanus* in the mollusca, and to the segmental organs of the annelids.

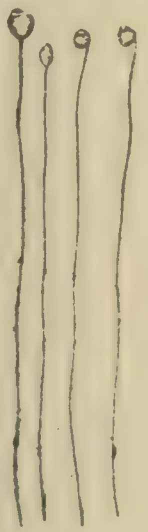

FIG. 193.—Spermatozoids of *Crania* much enlarged. (JOUBIN.)

It is generally believed that fecundation takes place after the discharge of the eggs into the pallial chamber or into the sea water. An interesting condition of fecundation occurs in LACAZELLA and CISTELLA, which compels the conclusion that the spermatozoids have penetrated from without into the visceral chamber and there fertilized the eggs.

A fold is formed by an expansion of the mantle, which incloses a number of fertilized eggs, attached to two very large brachial cirri, and while in this condition the segmentation of the embryo is effected. It is not known at precisely what stage of development these embryos are set free from the suspensory cirri and emitted into the outer chamber of the valves.

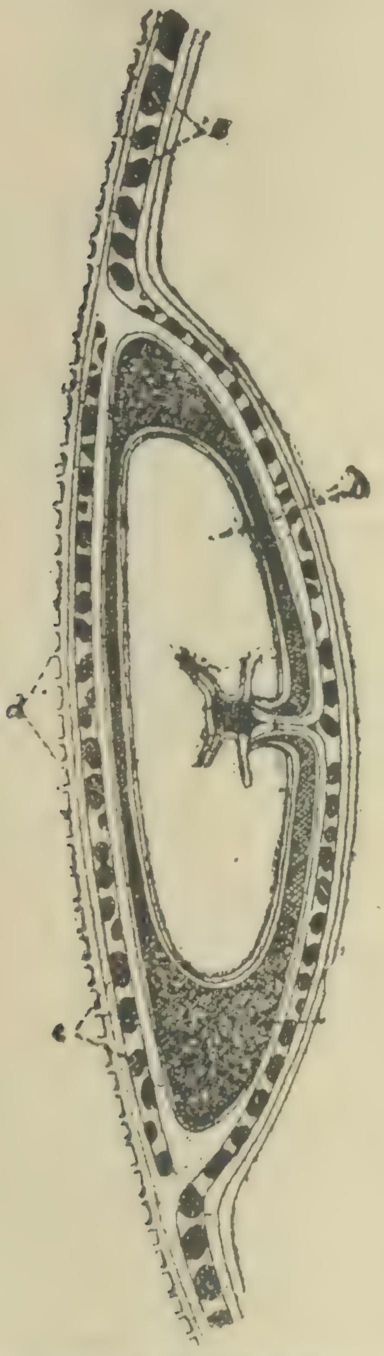

Fig. 194—Transverse section of mantle of *Magellania australis*. *a*, pallial sinus; *b*, genital organ; *c*, pallial lacunes; *d*, bases of pallial caeca. (Hancock.)

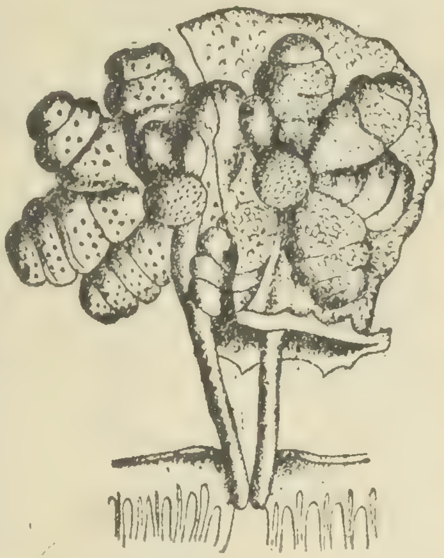

Fig. 195—Embryo-pouch of *Lacazella* partly broken, exposing clusters of segmented embryos attached to the suspensory cilia (Lacaze-Duthiers.)

In a specimen of *Lingula lamellata* from Upper Silurian, of Hamilton, Ontario, the pallial cavity has been found filled with ova; and Œhlert cites a specimen of Stringocephalus (Middle Devonian) in whose valves were found a number of embryo shells, which would indicate that development had taken place in this chamber. An accelerated growth of the reproductive organs and the perfection of their function is shown in certain species of Terebratella, which are capable of reproduction during the adolescent *magadiform* and *magaselliform* stages, thus perpetuating a more primitive race which does not attain the characters of the adult Terebratella.

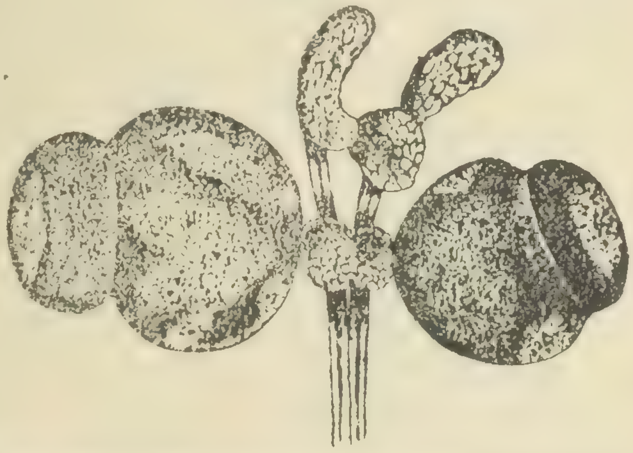

Fig. 196—Two embryos of *Lacazella* attached to the suspensory cilia. (Lacaze-Duthiers.)

DEVELOPMENT.*

From the fertilization of the *ovum* to that stage which may be regarded as terminating the embryonic period, the developing brachiopod passes through the conditions of

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* Our knowledge of the embryogeny of the living brachiopods is due to Owen, Hancock, Davidson, Morse, Kovalevski, Lacaze-Duthiers, Müller, Shipley and Brooks, and is pretty much restricted to the genera Terebratulina, Liothyrina, Cistella, Lacazella and Glottidia. The most important contributions upon the morphogeny of the brachiopod shell, are those of C. E. Beecher.

(1) *Protembryo;* unsegmented and segmented stages, before the formation of a primary internal cavity (blastula or segmentation cavity);

(2) *Mesembryo* or blastophere; a multisegmented body with an internal cavity (blastula cavity);

(3) *Metembryo* or gastrula; a concavo-convex body consisting of two layers formed either by the invagination of the blastula or by the duplication of its cell-layers;

(4) *Neoembryo;* the condition of primary division into a cephalic, caudal, and subsequently a thoracic lobe, with posteriorly directed mantle and bundles of thoracic setæ.

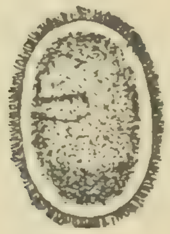


FIG. 197.—*Terebratulina.* First ciliated stage. (MORSE.)

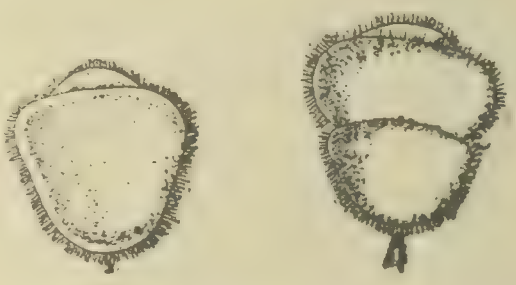


FIG. 198.—*Terebratulina.* Segmented embryos. (MORSE.)

(5) *Typembryo;* in which the mantle lobes have inverted and are folded over the cephalic lobe;

(6) *Phylembryo;* the state in which the characters of the brachiopod-type are defined.

When the egg becomes fertilized it may either remain attached to the mother and pass its early segmented stages in that condition, as in LACAZELLA, or it may be set free into the pallial chamber or into the sea-water. Some such ova develop cilia before segmentation (TEREBRATULINA) and are thus free swimmers; others evidently have no means of locomotion. Where the cilia

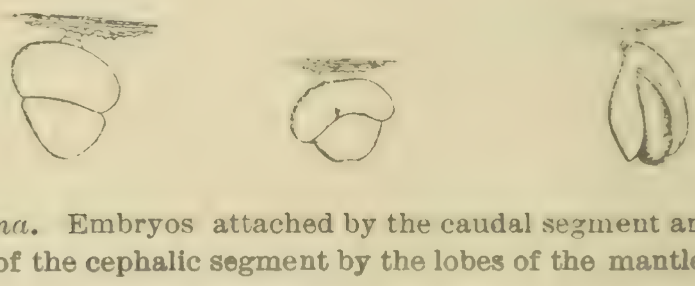


FIG. 199.—*Terebratulina.* Embryos attached by the caudal segment and showing the gradual inclosure of the cephalic segment by the lobes of the mantle. (MORSE.)

are developed in the unsegmented condition they are retained during the blastula and gastrula stages. With the completion of the primary segmentation and the formation of the segmentation cavity or archenteron, follows the division of the embryo into a cephalic and caudal lobe, and the formation of two lateral diverticula from the segmentation cavity. This is the primary *cephalula* stage of the neoembryo, which becomes completed by the development of a third, a median or thoracic lobe, from which four bundles of long setæ are extended posteriorly beyond the caudal lobe (CISTELLA). The cephalic and caudal lobes are cilated but the median lobe is not. At the same time a single pair of pigment-dots or eyes developed on the cephalic segment. In a later condition a second pair of eye spots appears, the thoracic or median lobe becomes elongated and its outer layer (*mantle*) differentiated from the body of the lobe. During this stage the embryo may become attached by its caudal segment or pedicle (TEREBRATULINA). The two divisions or lappets of the mantle, which in the last stage embraced the thoracic lobe are now inverted or revolved upon their basis of attachment, until they gradually inclose the cephalic lobe, and their margins, with the bundles of setæ, are directed anteriorly instead of posteriorly. This initiates the typembryo stage.

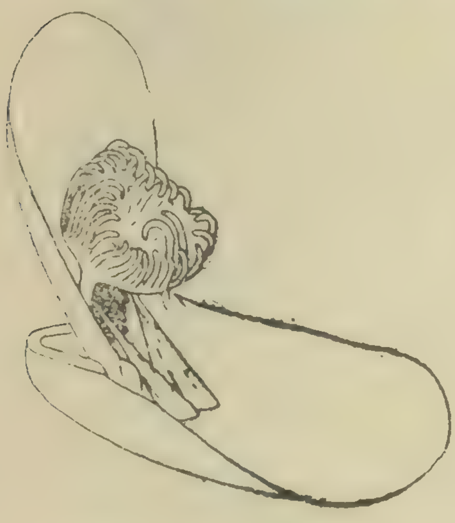


FIG. 200.— *Terebratulina;* a very young shell showing the ciliated arms or lophophore and the diductor muscles. x 20 (MORSE).

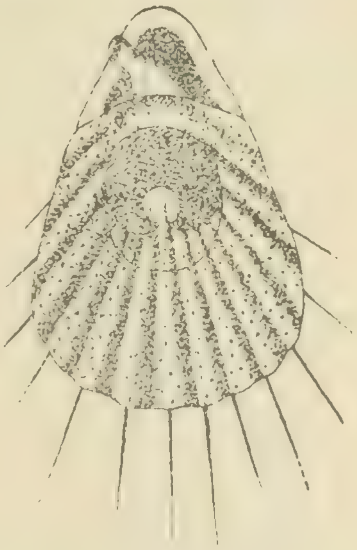


FIG. 201.— *Terebratulina*; a young shell having the punctæ developed. x 20 (MORSE).

At this time CISTELLA becomes attached by its caudal segment though the pedicle in GLOTTIDIA is not as yet developed.

The cephalic lobe now rapidly becomes diminished in size. The digestive tube had already been formed by the tubular enfolding of the walls of this lobe. The muscles in CISTELLA are now in four pairs, two of which extend from the walls of the digestive cavity to the bases of the marginal setæ; these afterward become the *adductor* muscles of the adult animal.

One pair extends to the caudal lobe and becomes the ventral *pedicle-muscles.* The fourth pair extends from the dorsal to the ventral wall of the body, just behind the digestive cavity; this becomes the *diductor* muscles. There is a fifth pair of dorsal pedicle-muscles in LIOTHYRINA.

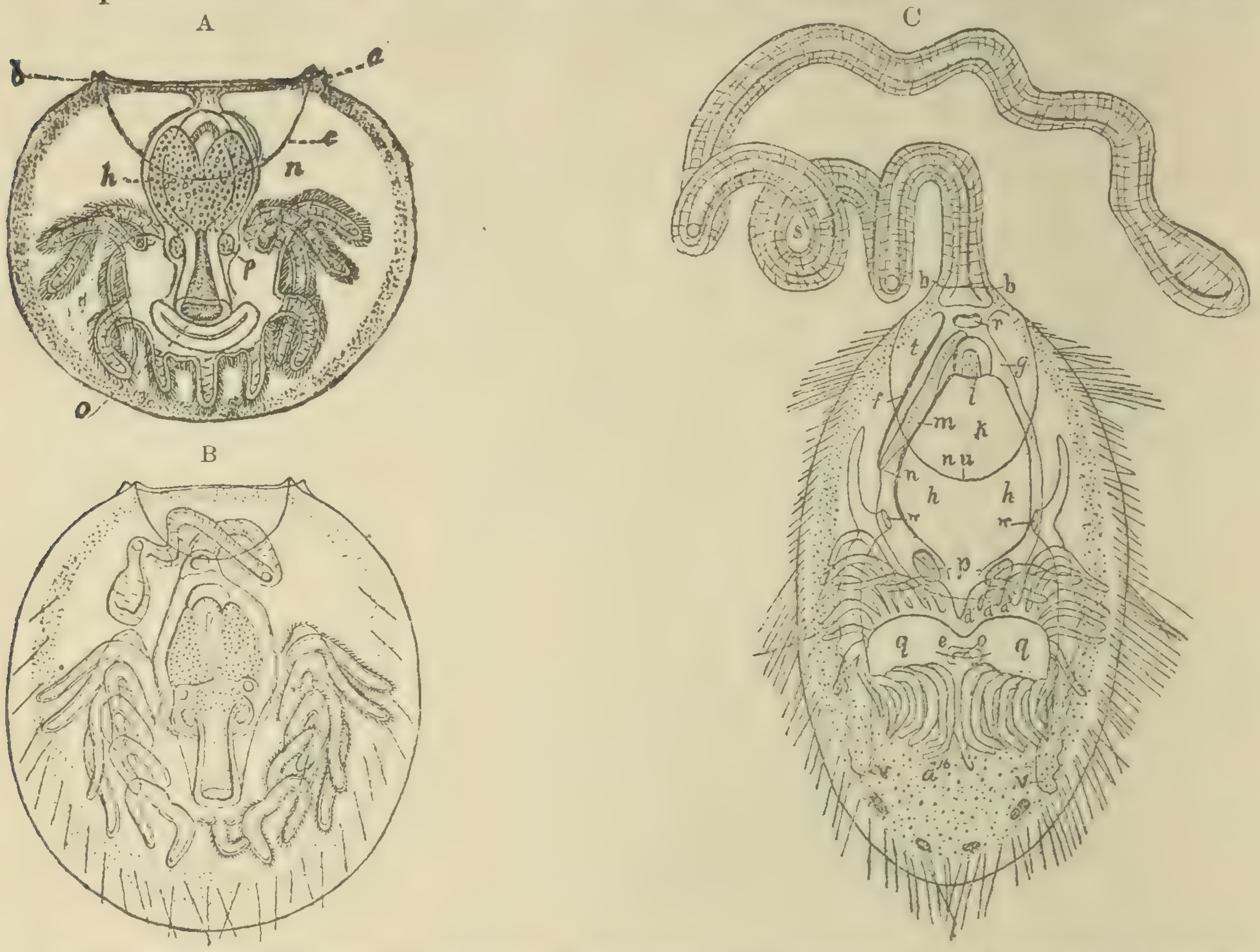


FIG. 202.— Embryonic stages of *Glottidia Audebarti.* A, Dorsal view of the youngest embryo observed; B, Dorsal view of a somewhat older embryo; C, Ventral view of an individual soon after becoming sedentary; *a*, hinge-teeth of brachial valve; *b*, hinge-teeth of pedicle-valve; *c*, semicircular plate of brachial valve; *d*, median tentacle; *f*, parietal bands; *g*, body cavity; *h*, liver; *k*, hepatic chamber of stomach; *l*, intestinal chamber of stomach; *m*, intestine; *n*, anus; *o*, mouth; *p*, muscles; *q*, lophophore; *r*, posterior unpaired muscle; **s**, pedicle; **v**, pallial sinus; *w*, its opening into the body cavity; *nu*, edge of larval shell. (BROOKS.)

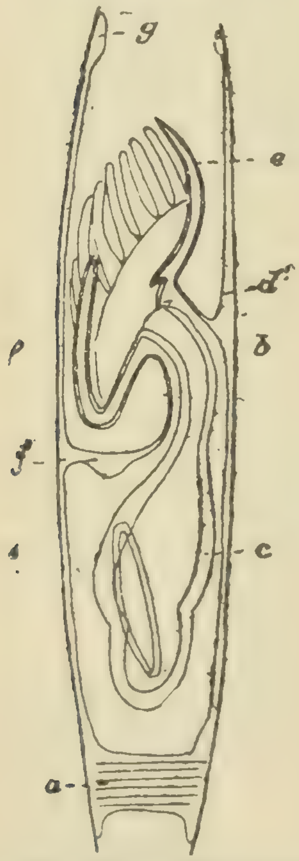


FIG. 203.— Diagrammatic longitudinal section of young of *Glottidia. p*, pedicle-valve; *b*, brachial valve; *a*, umbonal muscle; *c*, stomach; *d*, mouth; *e*, lophophore; *f*, ganglion; *g*, border of mantle.— (BROOKS.)

Following this condition the four bundles of setæ are lost, the eye spots disappear, the digestive tube and stomach become well defined, the cilia of the brachia or lophophore appear, and the valves of the shell, which before had been simple plates upon the surface of the mantle lobes, come into contact about their lateral and anterior margins. The animal has now taken on the appearance of a brachiopod and is a phylembryo. Later growth to the adult condition consists in the perfecting of the details now outlined in the embryo.

The Development of the Shell.

There are at least two types of shell development among the articulate brachiopods. One of these is exemplified by THECIDIUM, which has been shown by BEECHER to be a living representative of the extinct palæozoic group provided with a deltidium formed of a single plate or sheath; like STROPHOMENA and its allies. (Plate 16, Figs. 1-18.) The other is represented by CISTELLA, which typifies the group bearing discrete deltidial plates. In both of these, the first traces of the shell are found in the neoembryo. In the cephalula stage of *Thecidium* (*Lacazella*) *mediterraneum* the dorsal lobe of the mantle develops more rapidly than the ventral, and its inner surface bears a flat shell-plate. A similar plate is

FIG. 204.

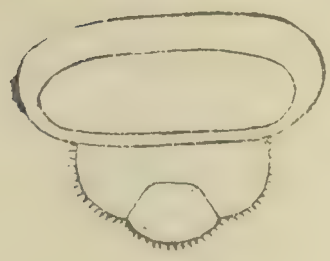


FIG. 206.

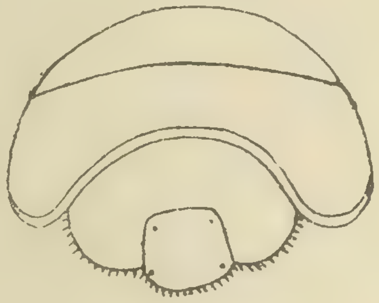


FIG. 209.

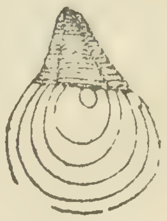


FIG. 205.

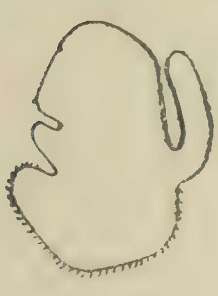


FIG. 207.

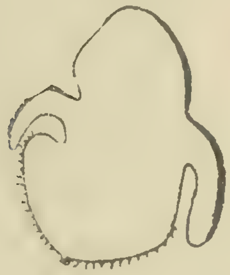


FIG. 208.

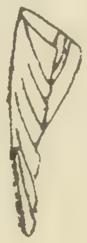
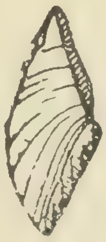


FIG. 210.



Thecidium (Lacazella) mediterraneum.

FIG. 204.—Cephalula, dorsal side; showing below, the cephalic segment with eye-spots, and on the upper segment the dorsal shell-plate.

FIG. 205.—Dorso-ventral longitudinal section of cephalula; below is the cephalic segment, at the right the dorsal mantle lobe, the thickened line on its inner margin representing the beginning of the dorsal valve, and the similar line on the adjoining side of the body the incipient deltidium.

FIG. 206.—A later growth stage (typembryo), in which the mantle lobes have turned downward. The body shell plate is seen in the upper part of the figure.

FIG. 207.—Dorso-ventral longitudinal section of the preceding: showing the inversion of both mantle lobes. The relations of the dorsal and body (deltidium) plates are shown by the heavy lines at the right. The ventral plate is also seen on the lobe at the left.

FIG. 208.—Profile of a very young specimen of *Leptæna rhomboidalis* oriented to correspond with the foregoing figures.

FIGS. 209, 210.—Views of adult *Thecidium (Lacazella) mediterraneum* similarly placed. (BEECHER; figs. 204-207, adapted from KOVALEVSKI.)

developed on the body of the thoracic lobe covered by this portion of the mantle. Subsequently, during the neoembryonic period, a shell-plate is also formed on the inner surface of the ventral lobe of the mantle. By the inversion of the mantle-lobes, these plates formed on their inner surfaces, become external and inclose the cephalic lobe. Their attached or inner edges, though separated by the entire width of the thoracic segment, make the hinge-line. The body-plate is now in contact with the dorsal-plate or valve at its inner edge, but does not touch the ventral valve, the two latter being separated by the width of the caudal lobe or pedicle. This body-plate, or third valve, is the incipient *deltidium*. Subsequently, by lateral extension, the dorsal and ventral valves come into contact at their cardinal

FIG. 211.

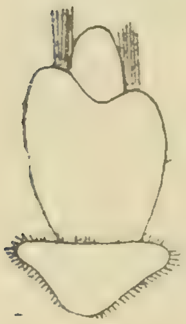


FIG. 213.

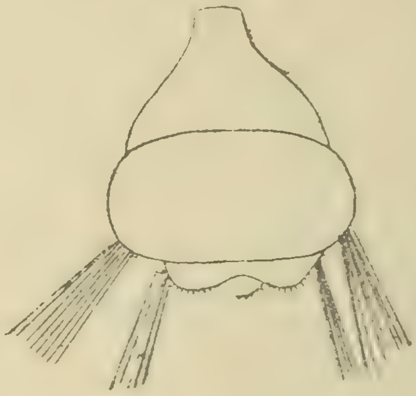


FIG. 215.

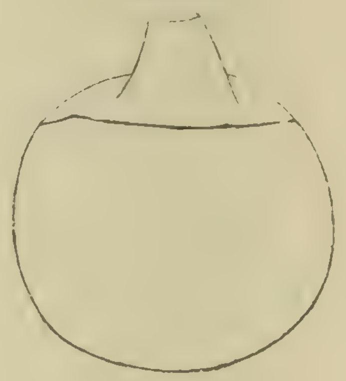


FIG. 212.

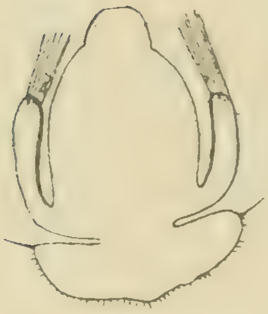


FIG. 214.

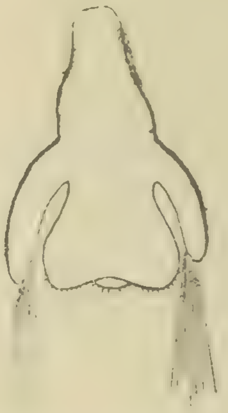
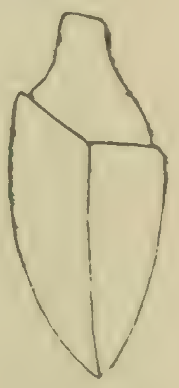


FIG. 216.



Cistella neapolitana.

FIG. 211.—The completed cephalula stage; the ventral and dorsal mantle lobes are at the right and left respectively.

FIG. 212.—Longitudinal section of the same; the shell secreting surfaces are represented by heavy lines.

Fig. 213.—Typembryo; the larva after the inversion of the mantle lobes.

FIG. 214.—Longitudinal section based on the preceding. The shell bearing surface of the mantle lobes are now on the outside of the animal, the large pedicle extending downward.

FIGS. 215 and 216.—Dorsal and profile views of a very young shell; showing the large posterior opening between the valves and the thick pedicle. (BEECHER, adapted from KOVALEVSKI and SHIPLEY.)

extremities; the ventral valve meets the deltidium and becomes anchylosed with it, leaving an opening for the passage of the pedicle. The union of the three shell-plates in the phylembryo forms the completed embryonic shell or *protegulum*.

In CISTELLA, and presumably in all articulate brachiopods possessing deltidial plates, the mode of development of the shell is quite different. The ventral lobe of the mantle is here the longer, and no body-plate is formed on either side of the thoracic lobe. When, therefore, the mantle lobes are reversed and the valves come into contact about their peripheries and at the cardinal extremities, the caudal lobe, or pedicle, occupies all the space between the posterior margins of the valves. The large,

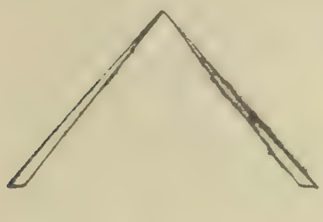


FIG. 217.—Dethyrium of a young *Rhynchonella* without deltidial plates.

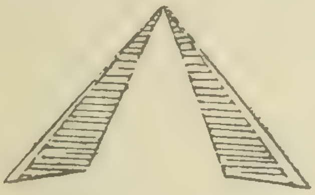


FIG. 218.—The same at a later stage with two triangular deltidial plates.

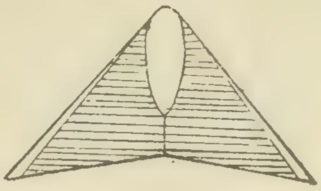
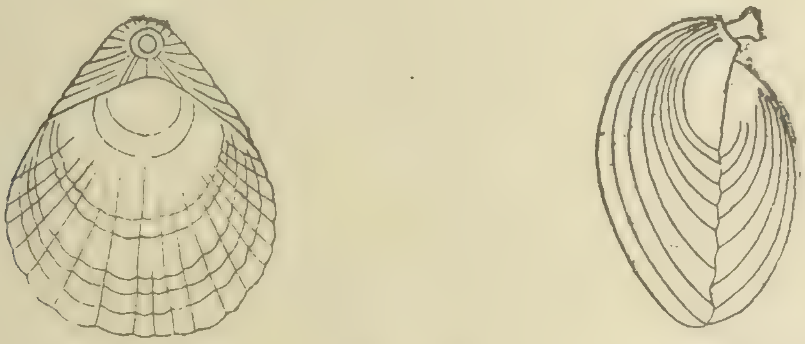


FIG. 219.—The same at completed growth of the deltidial plates.



FIGS. 220 and 221.—Dorsal and profile views of *Magellania flavescens*, showing deltidial plates and pedicle.

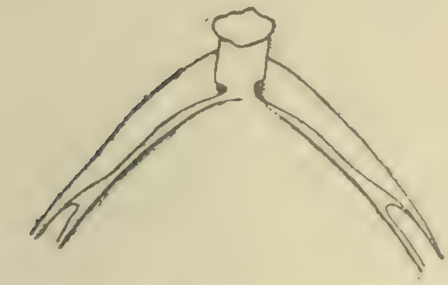


FIG. 222.—Dorsal view of the umbonal portion of an adult *Terebratulina septentrionalis* with the shell removed by acid; showing slight secondary extensions of the central mantle around the pedicle, small deltidial plates only, being secreted in this species.

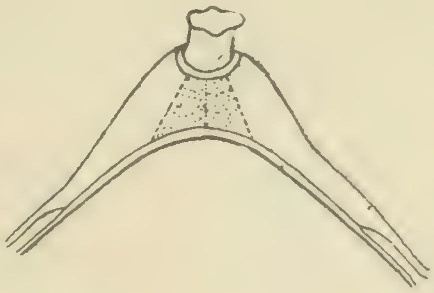


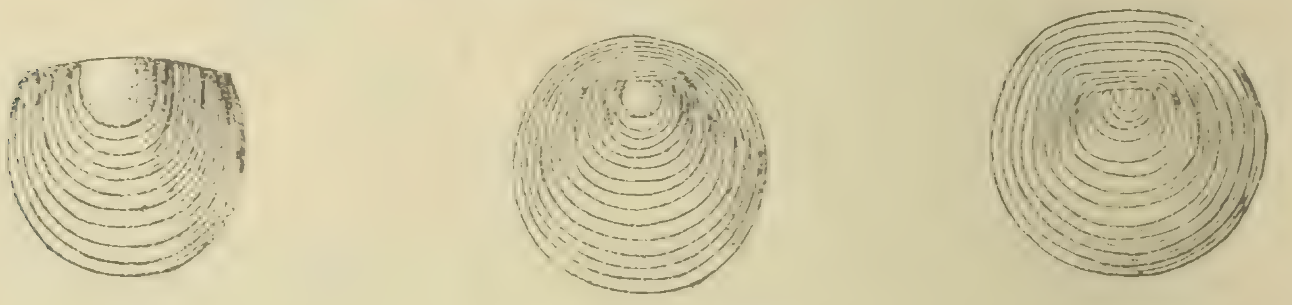
FIG. 223.—Similar preparation of *Magellania flavescens;* showing the complete envelopment of the base of the pedicle by secondary expansions of the ventral mantle which have formed the deltidial plates, as shown in fig. 220. (After BEECHER.)

triangular, unclosed fissure thus formed, persists throughout early post-embryonic growth-stages. It has already been observed that the period at which deltidial plates begin to appear, and the degree of development which they attain in this group, varies with the species. Thus in most forms of Rhynchospira and in *Meristina Maria* they are completed at an early adolescent stage, while in *Meristina rectirostra*, they are in a primary condition of development at maturity, and the pedicle is at no time restricted to a foramen.

In Magellania when the deltidial plates begin to develop, it has been found that they are secreted by secondary extensions of the ventral mantle from along the margins of the deltidium, these laminar processes beginning at the cardinal margin and meeting though not uniting along an axial line. (Beecher.)

It is therefore to be concluded that the deltidial plates are of post-embryonic or secondary growth and that the absence of the body-plate or deltidium in the embryo of Cistella is to be regarded as an instance of acceleration of development in which this primary phase has been omitted.

There is a difference in the intimate structure of the deltidium and deltidial plates, in punctate shells; the former being developed from the body of the thoracic lobe and not from the mantle, and has no punctæ; the latter, originating from the mantle, are perforated by its cæcal extensions.



Orbiculoidea minuta,

Three growth stages; showing the change from the paterina-stage with transverse cardinal margin, to the circular outline of the adult. Fig. 224 x 36; fig. 225 x 16; fig. 226 x 10; figs. 224 and 225 show the form of the protoconch. (Beecher.)

In many of the brachiopoda the *protegulum* or embryo shell is retained throughout later growth stages. This is true where the apices of the valves have not become greatly modified by the encroachment of the pedicle. Its valves are subsemicircular and smooth, the hinge-line straight and its general form exemplified in the adult condition of the primordial genus Paterina.

POST-EMBRYONIC STAGES.

With the completion of the protegulum and the incipient development of the lophophore, the embryonic condition of brachiopod may be regarded as closed. The subsequent periods in the life of the animal may be divided into (*a*) the infantile; (*b*) the adolescent; (*c*) the adult; (*d*) the senile.

During the infantile condition, additions made to the protegulum usually modified the outline of the shell, and bear only the concentric lines upon the surface. The cæcal perforations of the shell appear at this period (TEREBRATULINA). The animal is usually attached by its pedicle, but in GLOTTIDIA this organ is not yet protruded from between the valves. In the adolescent period the shell takes on the normal outline of the species, and surface plications and other external ornament and configuration now make their appearance. The lobes of the lophophore become developed, the digestive tract extended and completed, and, in GLOTTIDIA, the pedicle is protruded and highly developed. After passing the period of maturity, the senile shell undergoes various changes. Callosities and deposits of adventitious calcareous matter are formed about the internal processes; the valves are thickened instead of being increased in diameter, the characteristic ornamentation of the shell may be temporarily or permanently lost, and the surface become smooth. Growth in this period of decline is reversional, manifesting a resumption of infantile characters. HYATT has defined two stages of senile growth; one preliminary or progressional, that in which the characters of maturity are disappearing in the reverse order of their appearance; the other, extreme or final, when the shell has finally reverted to its own condition during the infantile period.

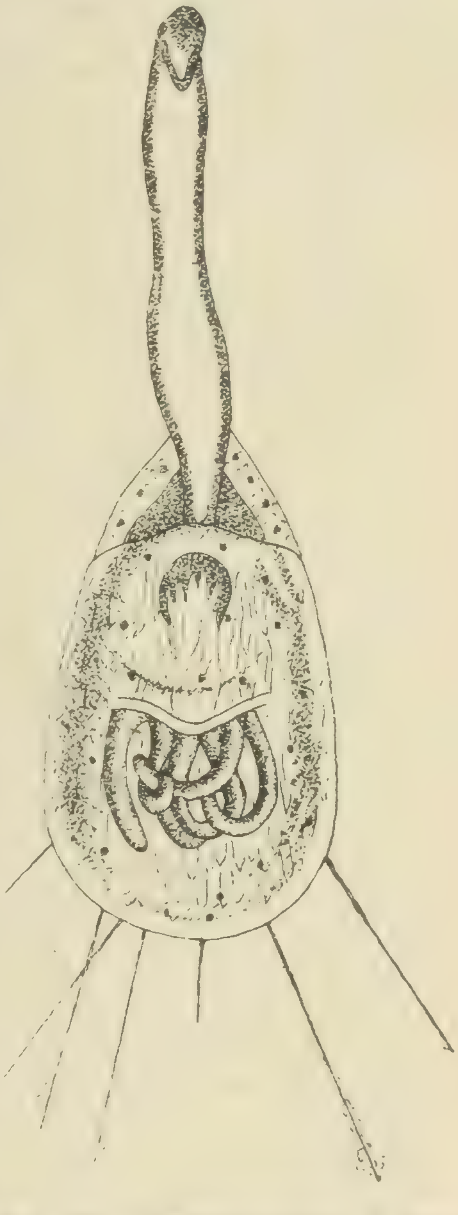


FIG. 227.—*Terebratulina*. A very young shell, with pedicle, cilia, setæ and punctæ developed. (x 300) (MORSE).

A chapter on CLASSIFICATION will follow the discussions of the genera.

THE GENERA OF THE BRACHIOPODA.

I.

BRACHIOPODA INARTICULATA.

Valves inarticulated; intestine terminating in an anus on one side of the body; shell substance largely phosphatic.

The foregoing characters bring into association a well defined assemblage of these organisms, but, while generally applicable throughout the group in expressing the fundamental distinctions from the more abundantly developed Brachiopoda Articulata, there often appear, in forms which can not be separated from such association, tendencies to transgress these limitations in various directions. For example, articulation of the valves was approached, if not effected, in the linguloid Barroisella, in Spondylobolus, and, perhaps also, in Neobolus and Trimerella. In Crania, according to the determination of Joubin, the anus opens in the median line of the body; and in various genera, Crania, Pholidops, Trimerella, etc., there is evidence that the substance of the shell was essentially, or altogether calcareous.

For this division of the Brachiopoda it seems preferable to adopt Professor Huxley's term, Inarticulata, as having the advantage of euphony and simplicity. Other writers have made use of terms with different significations, all having precisely the same scope. Professor Owen, in 1858, proposed the term Lyopomata (λύω and πῶμα), essentially the Greek equivalent of Inarticulata, and of Bronn's Ecardines. The last named author also suggested the term Pleuropygia, derived from the lateral position of the intestinal perforation; while King's term, Tretenterata, indicates that the existence of an anus is to be regarded as the essential character.

Lingula, Bruguière. 1789.

(Plate 1, Figs. 1–9).

Shells sub-equivalve; elongate-ovate, sub-quadrate or sub-triangular in outline; broad over the pallial region, cardinal slopes more or less conspicuous; slightly gaping at both extremities. Brachial valve somewhat the shorter, and with a slightly thickened hinge-line. Surface of the shell smooth, or concentrically and radiately striated. Animal attached by a long, muscular pedicle protruding from between the beaks of the two valves. The pedicle-valve has a distinct cardinal shelf or area, divided longitudinally by a depression widening from the apex anteriorly, and termed by KING the "deltidium." This, according to Professor KING, is usually not well developed, and in the average specimens of *L. anatina* found in museum collections, appears to be partially or quite wanting, from accidental causes. The deltidium is bounded at the sides by elevated ridges, which, at the anterior ends, are each developed into a small callosity.

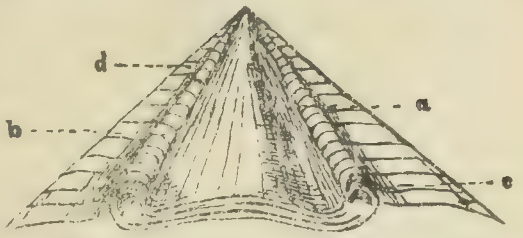


FIG. 228.—*Lingula anatina*; cardinal area of pedicle-valve, after KING. *a*, deltidium; *b*, deltidial ridges; *c*, deltidial callosities; *d*, areal borders.

Muscular impressions numerous, but usually indistinct. In the recent species they are twelve in number upon each valve, and are somewhat unsymmetrical in their arrangement. They may be designated as follows: The *umbonal* impressions (*g*), produced by a single muscular band passing directly across the cavity of the shell near the beaks, and by their contraction opening the valves; the *lateral* impressions, which are produced by three pairs of muscles, the *anteriors* (*j*) passing from near the lateral boundaries of the visceral area on the pedicle-valve, forward to the anterior extremity of this tract on the brachial valve; the *middles* (*k*) passing in just the opposite direction, from the anterior region of the pedicle-valve to the lateral region of the brachial valve; the *externals* (*l*) passing from the ante-lateral region of the pedicle-valve to the post-lateral region of the brachial valve, these muscles serving to move the valves forward and backward. The *central* impressions (*h*) are

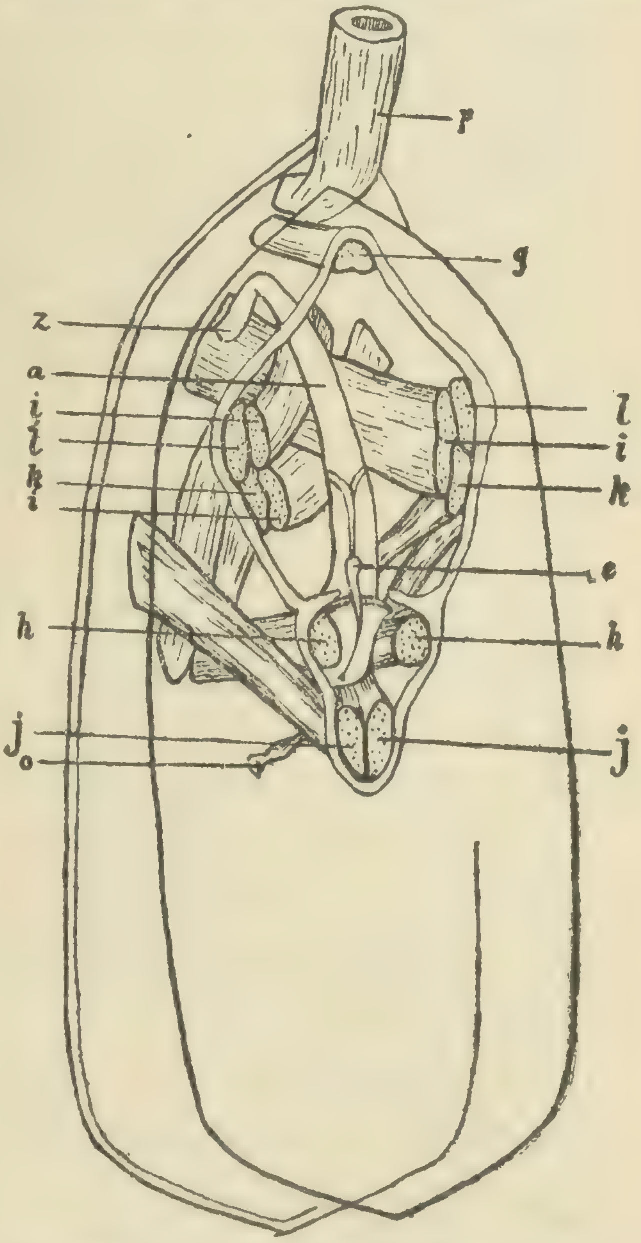


FIG. 229.—*Lingula anatina* after HANCOCK. *p*, pedicle; *g*, umbonal muscle; *h*, centrals; *i*, transmedians; *j*, *k*, *l*, laterals (*j*, anteriors, *k*, middles, *l*. externals); *e*, heart; *o*, mouth, *a*, alimentary canal; *z*, anus.

produced by a single pair of muscles extending across the antelateral region of the visceral area, and by the contraction of these, the valves are closed. The *transmedian* impressions (*i*), are made by a triple muscle, one band of which is on one side the visceral area, the other two on the other side, the two lateral components crossing each other in passing from the posterior region of the pedicle-valve to the medio-lateral region of the opposite valve. By the action of these muscles the animal is able to slide apart, laterally, the anterior and posterior extremities of its valves. The muscular region in each valve is surrounded by the *parietal* bands (*b*), which leave more or less distinct impressions upon the shell.

The anterior internal surface of each valve bears traces of two strong pallial sinuses, which nearly meet in the axial line before reaching the anterior margin. In front of, and behind these are to be seen radiating vascular markings.

Shell substance composed of alternating lamellæ of chitinous and calcareous material.

Type, *Lingula anatina*, Lamarck.

Distribution. (Cambrian?) Lower Silurian — Recent (China, Japan, Guinea, Australia, Philippines, Sandwich Islands.) The genus attained its culmination in the Silurian and Devonian, about seventy species being known from the former on the North American continent.

Remarks. There are at present no satisfactory means of separating generically, from the type of the genus, the great majority of fossils passing under the name of LINGULA. Internal casts bearing muscular and pallial impressions quite similar to those of recent species have been found in rocks as old as the Lower Silurian (Trenton), and whenever traces of such internal markings are preserved, there seems to be little difficulty in reconciling them with those of the living shells. Favorably preserved examples from the Carboniferous have shown even the unsymmetrical scars of the lateral or sliding muscles. In many of the extinct forms it is evident that the scars were deeper and the shells thicker and more calcareous than in the species now extant.

The retention of the pedicle in the fossil state has been observed in some Silurian and Carboniferous species.

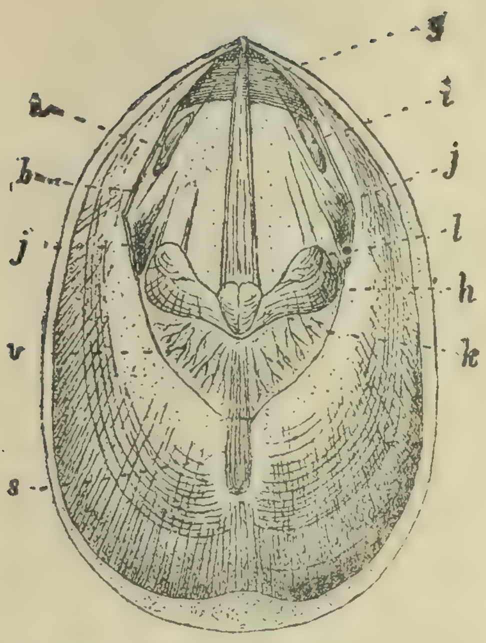


FIG. 230.—*Lingula paracletus*, HALL. Interior of pedicle-valve.

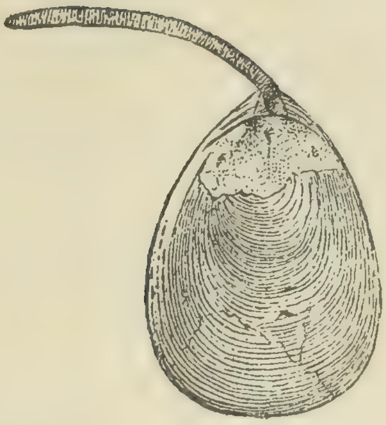
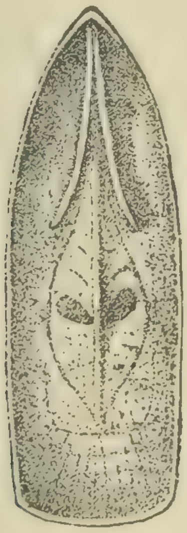


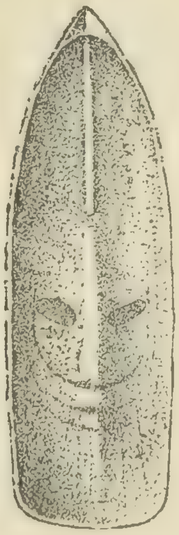
FIG. 231.—*Lingula ? Leseuri*, Ronault; with pedicle. (DAVIDSON.)

Subgenus **Glottidia**, Dall. 1870.

Animal free, and forming a tube or capsule about the pedicle by the agglutination of sand grains, etc.; pedicle highly contractile. Interior of pedicle-valve with two septal ridges diverging from the beak; brachial valve with a single median ridge.

Type, *G. albida*, Hinds (sp.)





Glottidia Palmeri.

FIG. 232.—Interior of pedicle-valve.
FIG. 233.—Interior of brachial valve. (DAVIDSON.)

Distribution. (Fossil ?) Recent (California, the Carolinas). This subgenus is regarded by Dall as the representative of LINGULA in American seas.

Subgenus **Dignomia,** Hall. 1871.

(Plate 1, figs. 12, 13.)

Shells with broad, flat median ridge and lateral, sub-marginal parietal grooves in the pedicle-valve, a more conspicuous median ridge in the brachial valve, with submarginal, diverging ridges corresponding to the grooves of the opposite valve.

Type, *Dignomia alveata*, Hall. Hamilton group (Devonian).

Subgenus **Glossina,** Phillips. 1848.

(Plate 1, figs. 10, 11.)

Outlines subtrigonal; beaks acuminate. Internal markings obscure.

Type, *Glossina attenuata*, Sowerby (Sp.).

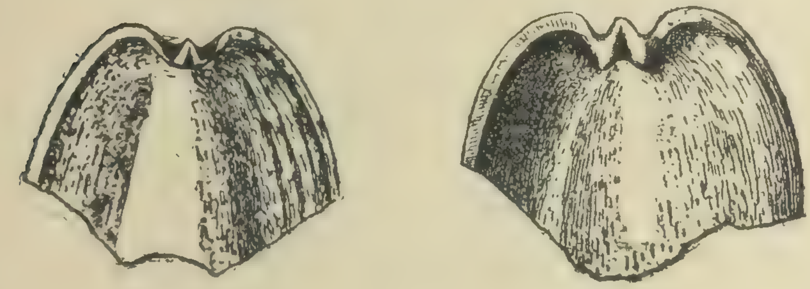
Distribution. Lower Silurian—Devonian (?).

Barroisella, Hall. 1892.

(Plate 1, figs. 14, 15.)

Shell externally as in LINGULA. The pedicle-valve bears a high cardinal area, which is a thickened triangular plate divided by a broad pedicle-groove. On the basal margin of the cardinal area, at the angles made by the lateral margins of the pedicle-groove, is a pair of bosses or condyles, which have served either as muscular fulcra, or, to some extent, as points of articulation with the opposite valve. The interior of the pedicle-valve bears a subquadrate depressed area lying directly beneath, and almost in continuation of the pedicle-groove; this may represent the umbonal muscular scar. From its ante-lateral angles diverge two sharply defined, linear depressions, which extend about one-fourth the length of the shell, and end abruptly. From outside and behind the extremities of these depressions, begins a pair of long, curved furrows, composed of two shorter curves, the posterior rounding over the extremities of the linear depressions referred to, the anterior and longer curves gradually approximating and nearly meeting at a point about one-third the shell's length from the anterior margin. These furrows are accompanied by low ridges along their inner margin. A low median ridge, with elevated edges, begins at the posterior umbonal impression, and continues to the center of the valve, widening near its anterior extremity. Just behind its termination is a pair of small, usually indistinct muscular impressions, probably the scars of the central muscles.

In the brachial valve the beak is scarcely prominent, and the muscular markings are essentially as in the opposite valve, but more sharply developed. Beneath the beak is a faint umbonal scar, the lines diverging from which are discernible. The long compound lateral curves have a considerably greater degree of curvature than in the pedicle-valve, their posterior portion inclosing a thickened area, which is continued into a peculiar low and thickened median septum, bifurcating in the middle of the valve, the angle being occupied by an intercalated ridge, which extends for twice the length of the branches of the septum. The central scars are situated further backward at the junction of the median septum with the posterior thickened area.



FIGS. 234, 235.—*Lingula Criei.* Internal cast and interior of posterior portion of pedicle-valve. (DAVIDSON.)

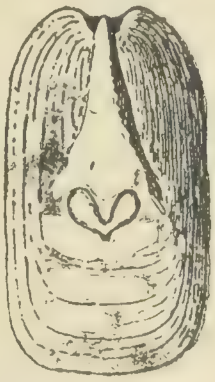


FIG. 236 —*Lingula Criei.* Internal cast of pedicle-valve. Natural size. (DAVIDSON.)

Type, *Barroisella subspatulata*, Meek and Worthen (sp.). Genesee slate (Devonian).

Distribution. Silurian—Devonian.

Subgenus **Tomasina**, Hall. 1892.

Externally like LINGULA. The pedicle-valve is very slightly convex, its posterior margin being notched. This notch is divided medially by a small triangular elevation at the base of which, on the inner margin of the valve, are two conspicuous articulating (?) processes.

Type, *Tomasina Criei*, Davidson (sp.). Silurian.

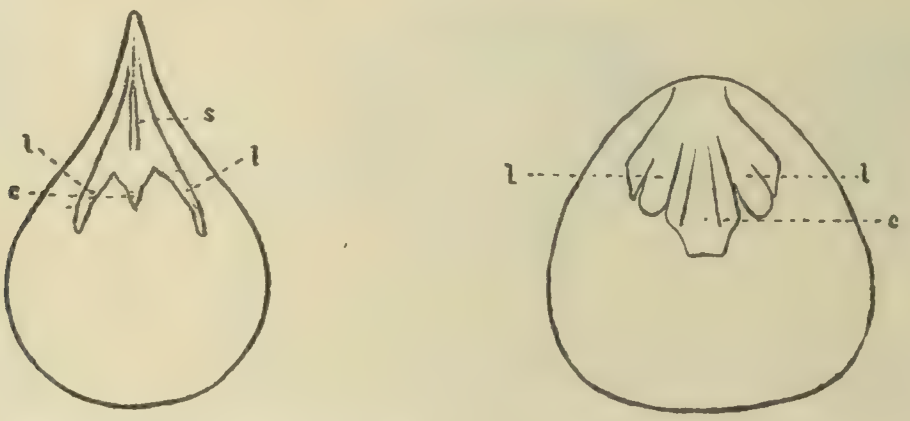
Lingulepis, Hall. 1863.

(Plate 1, figs. 16, 17.)

Shells linguloid; pedicle-valve attenuate and produced at the beak; brachial valve obtusely ovate.

On the interior the pedicle-valve bears a single large scar, occupying the entire umbonal region, which is produced anteriorly into two narrow lateral branches, extending for about one-half the length of the shell. Between them and continuous with their posterior portion, lies a central scar, not extending so far forward, but together with the lateral branches giving the entire muscular impression a strongly tripartite character. There is a low median ridge, elevated along its margins, depressed in the middle; similar to but fainter than in *Lingula anatina*.

In the brachial valve the muscular impressions make a conspicuous flabelliform scar, extending medially about one-half the length of the shell. The central portion of this scar is accompanied on either side by broader, partially resolvable lateral scars, all the subdivisions of the impression coalescing in the unbonal region. There is no septum in this valve.



FIGS. 237, 238.—*Lingulepis pinniformis.* *l*, lateral scars; *c*, central scars; *s*, septum.

Type, *Lingulepis pinniformis*, Owen (sp.).

Distribution. Cambrian. About six species are known in American faunas.

Lingulella, Salter. 1866.

(Plate 3, Figs. 1–4.)

Shells linguloid externally. The passage for the pedicle is a sharply defined slit, not merely making a depression upon the surface of the cardinal area but apparently penetrating it from apex to cardinal line. In the interior the pedicle-valve bears two long, narrow crescentic lateral scars, and shorter, more or less coalesced central scars, somewhat tripartite in outline.

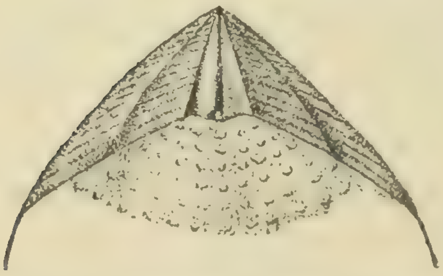
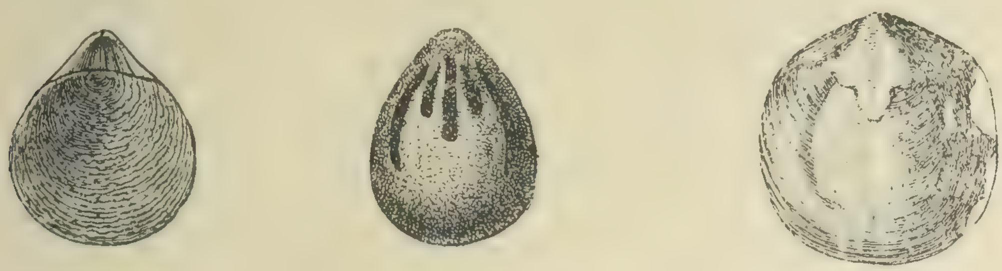


FIG. 239.—Cardinal area of *Lingulella Davisi.* (DAVIDSON.)

In the brachial valve are two diverging lateral scars, extending about one-half the length of the shell, and incurving at their anterior ends toward the more conspicuous, and apparently compound central scar.

Type, *Lingulella Davisi*, McCoy (sp.).



Lingulella Ella, Hall and Whitfield. FIG. 240.—Dorsal aspect, showing pedicle-area. FIG. 241.—Internal cast of pedicle-valve. FIG. 242.—Internal cast of brachial valve. (WALCOTT.)

Distribution. Cambrian — (?) Lower Silurian.

It is possible that the Devonian (Hamilton) species *Lingula paliformis*, Hall, belongs to this genus.

Lingulops, Hall. 1871.

(Plate 1, Figs. 18–20.)

Shells small, linguloid; both valves with a relatively broad cardinal area, which is divided transversely into two parts, (*a*) a smooth, narrow, apical portion; (*b*) a broad inner band, along which the valves appear to have been in contact. This band is flattened and projects into the interior cavity of the shell, like a narrow lunate shelf; on the pedicle-valve it is concentrically striated or smooth, and gently convex. The pedicle-groove crosses this inner area only, not encroaching on the apical area of either valve. Directly in front of the cardinal area, is a narrow crescentic ridge, the anterior margin of which is deeply excavated. This ridge, which is parallel and co-extensive with the cardinal area, bears a median angulation, projecting backward toward the pedicle-groove.

In the interior of the pedicle-valve is an elongate median muscular scar accompanied by two pairs of lateral scars. The median portion of the muscular area is thickened, forming an incipient platform, from the anterior edge of which extends a median septum. The posterior margin of the muscular area bears a trilobed parietal scar.

The interior of the brachial valve shows the cardinal area, pedicle-groove and the crescentic ridges essentially as on the opposite valve. The muscular scallops are represented by three depressions, closer together than in the other valve. The platform is here more highly developed and shows on its surface indications of the median and lateral muscular scars. No median septum is present in this valve.

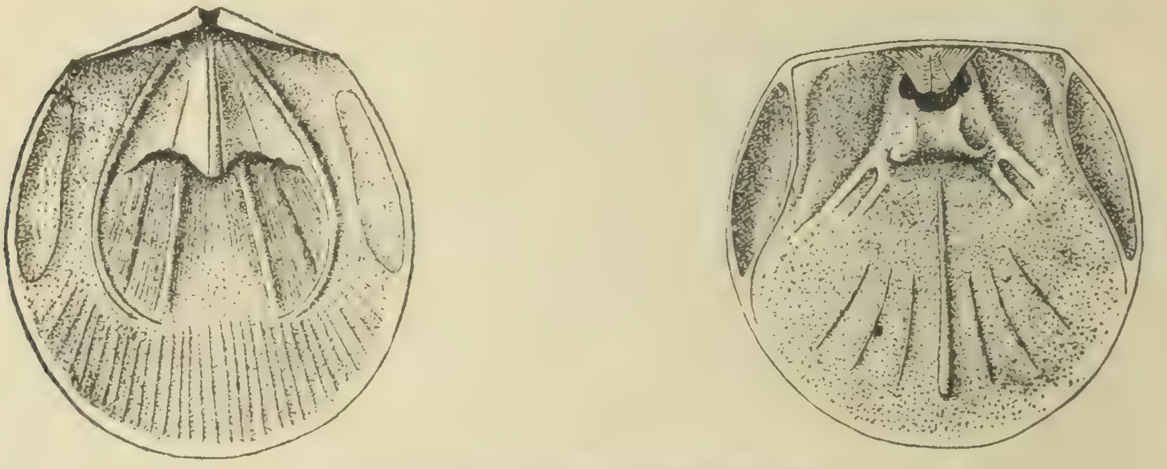
Type, *Lingulops Whitfieldi*, Hall.

Distribution. Silurian (Hudson River — Niagara groups). Four species are known in North and South American faunas.

Lakhmina, Œhlert. 1887.

Synonym ; *Davidsonella*, Waagen.

General outline more or less linguloid. The pedicle-valve is the larger and possesses a prominent apex, which is provided, on its lower surface, with a deep furrow for the pedicle. In the interior of the pedicle-valve, the cardinal margin is somewhat thickened, without forming a distinct area. Below this is a not very large triangular vaulted platform, supported by a median partition not extending beyond its anterior margin. This platform is inclosed by low, rounded ridges which originate near the pedicle-furrow; its surface is flattened medially, but concave on the sides. Of muscular impressions nothing has been observed. In the dorsal valve the cardinal margin is but little thickened and slightly curved. In the middle it bears a thickened process, which is directed somewhat upward and inward, extending partly into the apical cavity of the other valve. From beneath this process, a short thickened platform takes its origin; it is not even on the upper surface, but to all appearances spirally



Lakhmina linguloides, after WAAGEN.

FIG. 243.— Pedicle-valve. FIG. 244.— Brachial valve.

rolled; it is concave in the middle and bears on both sides elevated crests with sloping lateral faces; its anterior margin is curved inward, and the whole platform seems to be excavated below. From its sides diverge two bifurcating ridges, and a median septum extends nearly to the anterior margin. Near the lateral margins two sharply defined spaces are inclosed by narrow ridges. The interiors of both valves are marked with radiating striæ. Shells small; shell substance very thin.

Type, *Lakhmina linguloides*, Waagen (sp.). Obolus-beds of India (Cambrian). But one species is known.

Lingulasma, Ulrich. 1889.

(Plate 1, Figs. 21–24.)

Shells large, sub-quadrate, linguliform, sub-equivalve; the brachial valve considerably the deeper. Beaks apical, cardinal margins gently sloping to the sides. External surface covered with concentric or radiating lines and bead-like granules. Shell substance thick, largely calcareous.

Interior of the pedicle-valve with a low, concave platform which extends over one-half the length of the shell, and is not hollowed on its anterior wall. The pedicle-area has been largely inclosed within the shell, making a distinct sheath or shelf, beneath which lie the apical portions of the central and lateral muscular scars. Crescentic scars scarcely defined.

The brachial valve is deep, with a high platform of about the same extent as that on the other valve, sloping inward near its anterior margin and continued axially into a strong septum which reaches nearly to the front of the valve. The anterior walls of the platform are broadly excavated, and close against the base of the septum are hollowed out into short conical cavities. The crescent is strongly developed, sharply pointed backward at its center. Its lateral curves are broad, reaching to the edge of the platform. Directly in front of its central angle lies a short, sharp, median ridge, which disappears near the center of the platform. Lateral and central muscular scars well developed.

Type, *Lingulasma Schucherti*, Ulrich. Hudson River group (Lower Silurian).

Trimerella, Billings. 1862.

(Plate 2, Figs. 9–12.)

Synonym; *Gotlandia*, Dall. 1870.

Shells thick; outline ovate.

Pedicle-valve with an erect and straight umbo, which is usually solid for the greater part of its length, but double-chambered toward its base; cardinal area very prominent; deltidium broad; deltidial ridges more or less conspicuous; deltidial callosities slightly developed; cardinal slope well-defined. Crescent sharply incised over its summit, but faint toward the sides, where it is connected with the broad lateral and terminal scars, which are not so distinctly outlined as in the allied genera. Platform long, narrow and strongly developed; platform vaults tubular, the

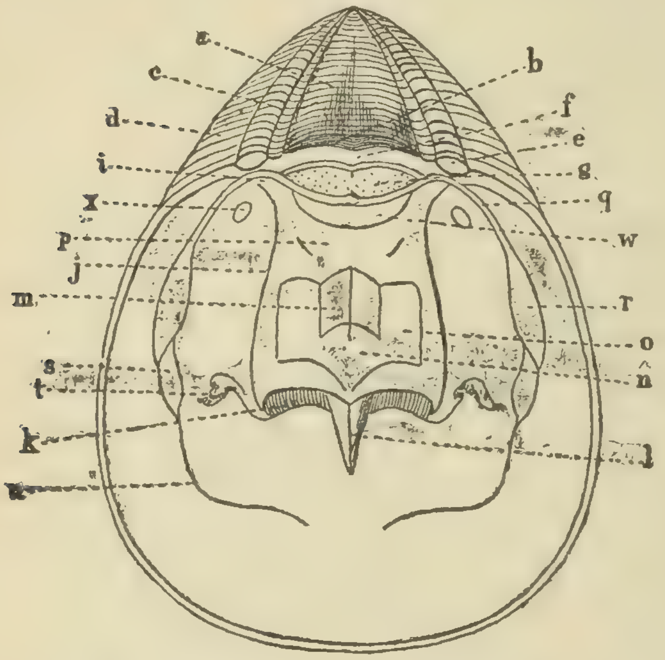


FIG. 245.— Pedicle valve of *Trimerella*.

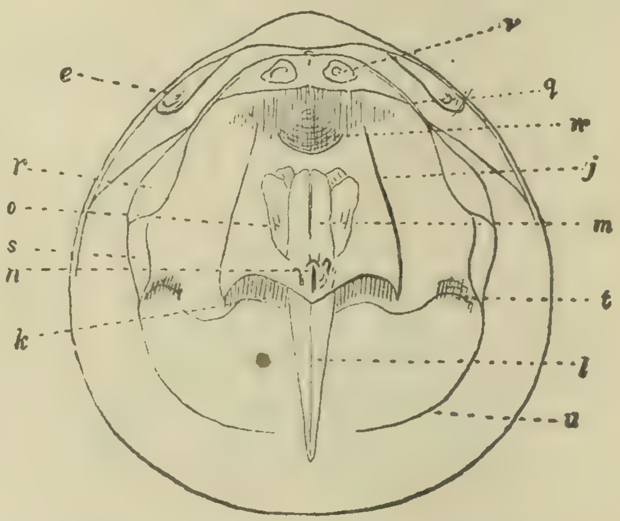


FIG. 246.— Brachial valve of *Trimerella*.

After DAVIDSON and KING.

a, deltidium.
b, deltidial slope.
c, deltidial ridges.
d, areal borders.
e, cardinal callosities.
f, cardinal facet.
g, lozenge.
h, cardinal buttress.
i, umbonal chambers.
j, platform.
k, platform vaults.
l, median plate.
m, median scars.
n, anterior scars.
o, lateral scars.
p, post-median scars.
q, crown }
r, side } crescent.
s, end }
t, transverse scars.
u, archlet (vascular sinuses).
w, sub-cardinal scars.
x, umbo-lateral scars.

e, cardinal sockets.
j, platform.
k, platform vaults.
l, median plate.
m, median scars.
n, anterior scars.
o, lateral scars
p, post-median scars.
q, crown }
r, side } crescent.
s, end }
t, transverse scars.
u, archlet (vascular sinuses).
v, cardinal scars.
w, sub-cardinal scars.

dividing wall being continued as a short septum in front of the platform. Muscular scars of the platform usually extremely faint, but under favorable preservation divisible into median and lateral components. Pallial sinuses faint.

Brachial valve with a marginal beak, which is much thickened in some instances, without producing a cardinal area, though making a prominent apophysis which is extended against the cardinal slope of the opposite valve. Crescent as in the other valve. Platform higher than in the pedicle-valve, its vaults extending scarcely so far backward. Anterior median septum long, often reaching almost to the margin. Muscular and pallial impressions faint.

Type, *Trimerella grandis*, Billings.

Distribution. Upper Silurian. (Illinois, Wisconsin, Ohio, Province of Ontario, Gotland, Farö.) Five species are known in American faunas and two additional species occur in the Swedish rocks.

Dinobolus, Hall. 1871.

(Plate 2, Figs. 1–4.)

Synonyms; *Conradia*, Hall, 1862; *Obobellina*, Billings, 1871.

Shell sub-circular; valves convex, thick.

Pedicle-valve with an acute and slender beak; cardinal area triangular, more or less elevated, but never so high as in TRIMERELLA or MONOMERELLA. Cardinal margins sometimes of considerable width. Umbo generally solid, but often slightly excavated on either side of a simple or double vertical wall, or buttress. Crescent distinct, its apex making a retral angle; narrow over the crown, widening into the great terminal scars. Platform low, broadly V-shaped on its anterior margin, which usually lies at about the middle of the valve; generally, with very short, flattened, abruptly conical vaults, but occasionally these vaults are of the same relative length as in TRIMERELLA, though much shallower. Central and lateral muscular scars on the platform usually distinct, the former lying in a depressed median groove, the latter occupying the greater portion of the surface. Subcardinal and anterior scars rarely discernible. Anterior median septum scarcely developed. Pallial sinuses faint.

Brachial valve with the beak submarginal, inconspicuous, usually not discernible; hinge-area very narrow. Crescent very strong, especially over the crown, where it makes a sharp posterior angle beneath the beak, sloping thence very gently, being almost transverse for about the width of the platform, then bending quite abruptly and being slightly interrupted at the position of the terminal scars, which are more approximate than in the opposite valve. In the type-species, the crown of the crescent, as usually developed, is a sharply incised, narrow furrow, bounded within by a broad elevation sloping to the position of the subcardinal scar, but not infrequently it is a ridge, bounded in front and behind by a deep furrow. This difference in appearance is due to the varying development of the anterior furrow, which is sometimes quite suppressed. Platform narrower and more sharply V-shaped than in the opposite valve; vaultsusually very short and abruptly conical. Lateral and central scars on the platform conspicuous, the latter lying in a deep median furrow, at the front end of which are sometimes seen the faint anterior scars. In the line of this furrow, directly in front of the apex of the crescent, lies the deep impression of the subcardinal muscle, which make a prominent feature on the cast, suggestive of the filling of the umbonal cavity, which it may be to some extent, although the apex of the beak is actually quite remote from it. From this point to the center of the crescent extends a short furrow, on either side of which lies the impression of an accessory scar, probably correlative with the umbo-lateral scars of RHINOBOLUS and TRIMERELLA. Pallial sinuses more or less distinct. Median septum low, but stronger than in the opposite valve. External surface smooth or with concentric, sublamellose growth-lines.

Type, *Dinobolus Conradi*, Hall.

Distribution. Lower and Upper Silurian. Nine species have been recorded, one from the Lower Silurian of Brittany, another from Esthonia, three from the same division in North America, one in the Upper Silurian of North America, Gotland and Bohemia, and three from the same division in Great Britain.

Monomerella, Billings. 1871.

(Plate 2, Figs. 5, 6.)

Shell usually thick; outline varying from elongate-ovate to subcircular. Surfaces of contact of the valves sometimes conspicuously broad.

Pedicle-valve with a more or less elevated umbo, which may vary in height in a given species; umbonal cavity divided into two chambers by a longitudinal septum. Cardinal area large; deltidial ridges and deltidial callosities not always distinctly developed; cardinal slope usually well defined, merging anteriorly into the cardinal buttress, or umbonal septum; in some species this slope, or subtriangular area, is longitudinally divided by a furrow. The crescent is sharply impressed over the cardinal slope; terminal scars broad and distinct. Platform more or less developed; divided by the cardinal buttress, which extends nearly or quite its entire length. Muscular impression on the platform very large, covering the entire surface, but scarcely resolvable into separate scars. Anterior septum faint, usually imperceptible. Pallial sinuses sometimes clearly defined.

Brachial valve with the umbo seldom conspicuously developed, the umbonal cavity being usually simple and deep, but sometimes filled by a deposition of shelly matter. Crescent sharply impressed over the narrow cardinal slope, and produced into broad, indistinct, composite, terminal scars. Platform usually well developed and broadly excavate on its anterior walls, but sometimes scarcely discernible. Anterior and lateral scars sharply defined, giving a tripartite appearance to the platform. Anterior septum more strongly developed than in the opposite valve.

Type, *Monomerella prisca*, Billings.

Distribution, Upper Silurian. Eight species are known, six of which occur in the Niagara and Guelph faunas of North America, two on the island of Gotland and one in Livonia.

Rhinobolus, Hall. 1871.

(Plate 2, Figs. 7, 8.)

Synonym; *Obolellina* (*partim*), Billings. 1871.

General form of the shell as in TRIMERELLA. Pedicle-valve, in the typical species, with an elevated, solid beak, having a broad and high deltidium, divided into a relatively narrow central area (which may be concave or convex), and broad deltidial ridges. Crescent and terminal scars as in TRIMERELLA. Umbo-lateral scars sharply defined. Platform very low and incompletely developed, consisting of a broadly V-shaped elevation, with a raised anterior margin, and surface sloping abruptly backward to, or even below the general curvature of the internal surface. A faint longitudinal septum extends forward from the platform.

Brachial valve with low, sub-marginal, slightly-curved apex, and short deltidium. Crescent conspicuously developed. Platform as in the opposite valve, with the addition of a central scar, which gives the entire area a tripartite appearance. Median septum faint.

Type, *Rhinobolus Galtensis*, Billings (sp.).

Distribution. Upper Silurian; Niagara and Guelph faunas of North America; two species.

Obolella, Billings. 1861.

(Plate 3, Figs. 5–7.)

Synonym; *Dicellomus*, Hall. 1871.

Shell inarticulated, ovate or suborbicular, lenticular, smooth, concentrically or radiately striated, sometimes reticulated by both radiate and concentric striæ. Ventral valve with solid beak and a small, more or less distinctly grooved area. In the interior of the ventral valve there are two elongated, sublinear or petaloid muscular or vascular impressions, which extend forward from near the cardinal scars, sometimes to points in front of the mid-length of the shell. These are either straight or curved, parallel with each other, or diverging toward the front. Between these, at about the middle of the shell, is a pair of small impressions, and close to the hinge-line a third pair, likewise small, and often indistinct. There is also, at least in some species, a small pit near the hinge-line, in which the groove of the area seems to terminate.

The dorsal valve has a small, nearly flat hinge-facet; the minute beak is slightly incurved over the edge of the area. Beneath the beak there is a small subangular ridge, on each side of which there is a cardinal (?) scar. The elongate scars, which seem to correspond to the lateral impressions in the ventral valve, are here altogether in the upper half of the shell, diverging widely in their extension forward, and are generally very slightly impressed. In the cavity of the valve there is a low, rounded median ridge, which extends from a point near the hinge-line forward to a little below the mid-length of the valve. About the middle of the shell there are two small scars. These are usually striated longitudinally, the median ridge passing between them. The area is coarsely striated.

Type, *Obolella chromatica*, Billings.

Distribution. Cambrian —— (?) Lower Silurian. The description by MICKWITZ of the interior of a species from the Ungulitensandstein, considered by him an OBOLUS (*O. Quenstedti*, Mickw.), renders the generic distinction between OBOLUS and OBOLELLA, for the time being, somewhat obscure. *Obolus Quenstedti* seems to possess the characters of OBOLELLA rather than of OBOLUS. The determination must rest upon future studies of *Obolus Apollinis*, Eichwald.

Elkania, Ford. 1886.

(Plate 3, Figs. 13, 14.)

Synonym; *Billingsia*, Ford. 1886.

Shells ovate or circular, biconvex; shell substance largely corneous and distinctly laminated. Apex of pedicle-valve marginal; within it is a broad subtriangular depression which merges into a deep central spoon-shaped cavity. Two narrow furrows diverge from its anterior extremity, separating the broad lateral muscular scars. Two small submarginal grooves pass from the beak outward, skirting the posterior portion of the lateral impressions, and appear to terminate in distinct subcircular scars situated near the lateral margins of the valve.

In the brachial valve is a thickened area in the umbonal region, presenting the appearance of a false cardinal area within the cavity of the umbo. This area is tripartite, bearing a deep, narrow central, and two broader lateral grooves; about its anterior margin lie two broad scars of the same character as the laterals of the other valve. There are also diverging furrows, which, starting at the marginal apex, pass over the edge of the thickened area, and are most deeply impressed at their anterior extremities.

Type, *Elkania desiderata*, Billings (sp.). (Cambrian; one species.)

Leptobolus, Hall. 1871.

(Plate 3, Figs. 8–12.)

Shells small, fragile, subovate in outline; shell substance semiphosphatic. Exterior with concentric growth-lines. The interior of the pedicle-valve shows a notably large cardinal area, which is sharply grooved. Beneath this area, in the bottom of the valve, is a broad depression extending nearly across the shell, and divided by a low median ridge, which bifurcates at its extremity, leaving between its branches a small central muscular impression. This impression is bounded on its sides by a crescentic muscular fulcrum, which extends parallel with the margins to the anterior portion of the shell. At a point back of their centers each gives off a transverse branch extending inward and backward. The portion of the valve lying between the anterior horns of the lateral semilunes is also deeply depressed, but its surface shows no markings. In the brachial valve the cardinal area is also well developed and distinctly grooved. The limits of the muscular scars are indicated by three septal ridges, one axial and one at either side. All these ridges are bifurcated at their anterior extremities.

Type, *Leptobolus lepis* Hall. Upper Silurian. Three species have been described, all from the Hudson River group and Utica slate of North America.

Paterula, Barrande. 1879.

(Plate 3, Fig. 15.)

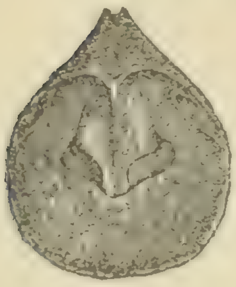
Shells small, oval, with broad margins of contact. Pedicle notch posterior and marginal. Interior of the pedicle-valve with two or four short, faint ridges diverging from the beak. External surface concentrically striated.

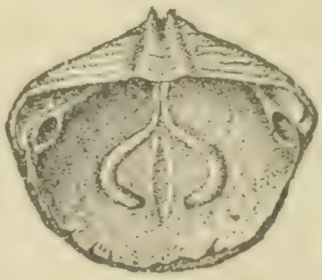
Type, *Paterula Bohemica* Barrande. Lower Silurian (Etage D). These shells are but imperfectly understood. Besides the single Bohemian species a somewhat similar form occurs in the Llandeilo of Great Britain, and in a lower Silurian limestone in the city of Quebec, Canada.

Obolus, Eichwald. 1829.

Synonyms; *Ungula*, Pander, 1830; *Aulonotreta* (*partim*), Kutorga, 1847; *Ungulites*, Bronn, 1848; Quenstedt, 1871.

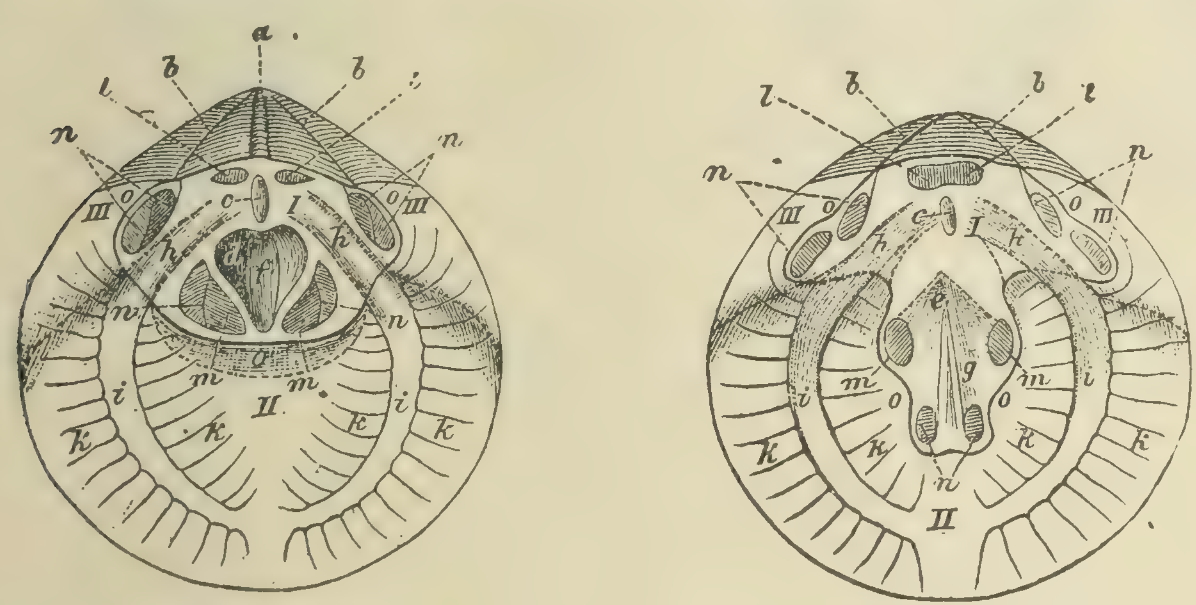
Shells externally much like those of OBOLELLA, but generally larger and somewhat flatter. The valves are unarticulated, both having broad, grooved cardinal areas, though the groove on the brachial valve is sometimes obsolescent. The interior of the pedicle-valve shows a pair of well-defined cardinal or posterior adductor impressions, just behind the





Obolus Apollinis.
FIG. 247.—Pedicle-valve. After DAVIDSON.
FIG. 248.—Brachial valve. After KUTORGA.

cardinal area and separated by a more or less developed median septum extending to about the center of the valve. The "laterals" are well developed and occupy a position not equivalent to the impressions in OBOLELLA which have been designated by this term, but more nearly to that of the terminal scars of the crescent in DINOBOLUS. The median area of the valve on each side of the septum is much thickened, and at its anterior edge lie the conspicuous central scars. In the brachial valve the cardinal and "lateral" (external or terminal) impressions are developed as in the opposite valve, and in the central region is a pair of curved impressions. These inclose an indistinct central scar.



Larger valve. Smaller valve.

FIGS. 244, 245—Diagrammatic view of *Obolus Quenstedti*. After MICKWITZ.

a, Pedicle-groove; *b*, impression left by the advance of the lateral sliding muscles; *c*, median septum; *d*, cordate pit; *e*, sinus; *f*, median groove; *g*, median swelling; *h*, lateral grooves; *i*, impressions of vascular trunks; *k*, impressions of secondary sinuses; *l*, impressions of posterior adductors; *m*, impression of anterior adductors; *n*, impressions of sliding muscles; *o*, outline of splanchnocœle; I, splanchocœle; II, brachiocœle, III, pleurocœle

Type, *Obolus Apollinis*, Eichwald. Cambrian (Unguliten-schichten).

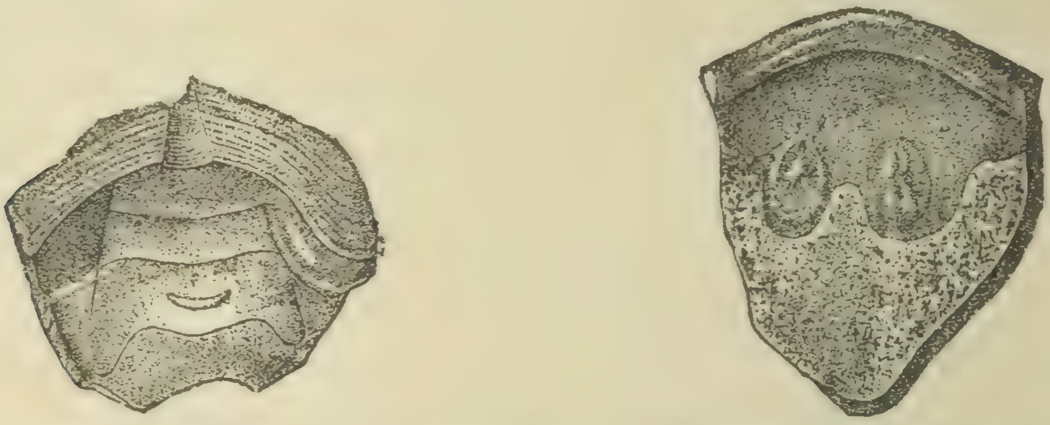
MICKWITZ has elaborated the internal impressions of his species *Obolus Quenstedti*, showing that it possessed a very complicated muscular system not unlike that of LINGULA. It is, however, not satisfactorily demonstrated that this species is a true OBOLUS.

Aulonotreta, Kutorga. 1848.

Synonym; *Acritis*, Volborth, 1869.

(This name was proposed to take the place of OBOLUS, Eichwald, 1829. The first type is *A. polita*, Kutorga = *Obolus Apollinis*, Eichwald; the second, *A. sculpta*, Kutorga = *O. antiquissimus*, Eichwald, was taken by VOLBORTH as the type of ACRITIS. The latter species is imperfectly known. MICKWITZ regards both AULONOTRETA and ACRITIS as synomyms of OBOLUS).

Pedicle-valve with a broad, subquadrate muscular scar crossed on its posterior portion by a transverse band connecting what appear to be cardinal scars.



Aulonotreta antiquissima. After VOLBORTH.

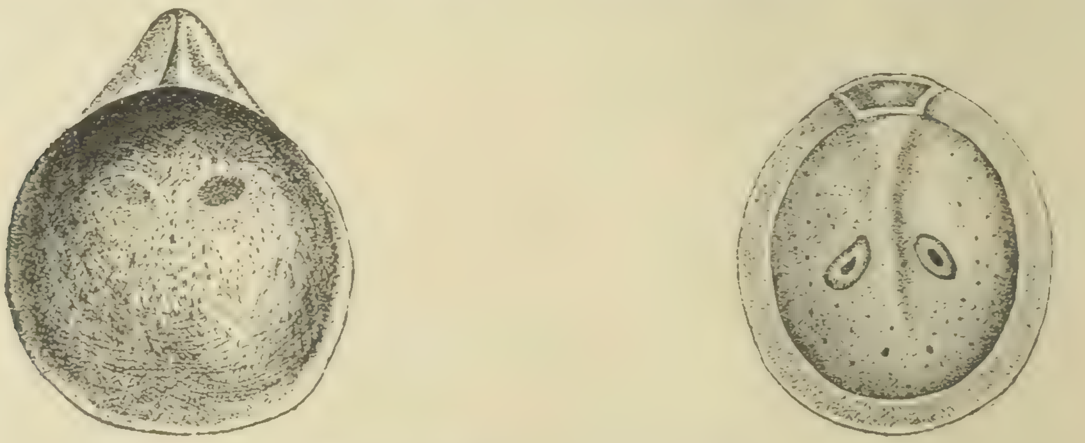
FIG. 246.—Interior of pedicle-valve. FIG. 247.—Interior of brachial valve.

In the brachial valve are two subcircular scars in the median region just within the posterior margin.

Type, *Aulonotreta antiquissima*, Eichwald. Cambrian.

Schmidtia, Volborth. 1869.

Pedicle-valve with a broad, centrally-grooved cardinal area, and, in the middle of the valve, two obliquely oval muscular impressions separated by an elevated ridge. In the brachial valve is also a low median ridge and a single pair of oval impressions.



Schmidtia celata. (VOLBORTH.)

FIG. 248.—Interior of pedicle-valve. FIG. 249.—Interior of brachial valve.

Type, *Schmidtia celata*. Cambrian (Unguliten-schichten).

MICKWITZ considers this a synonym for OBOLUS.

Monobolina, Salter. 1865.

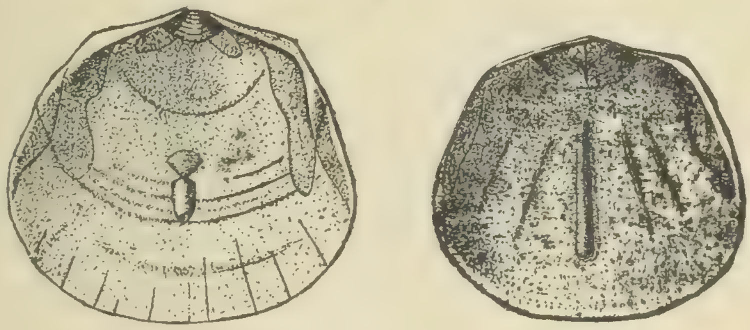
(Plate 4, Figs. 14, 15.)

Large oboloid shells with muscular scars concentrated along the median line.

Type, *M. plumbea*, Salter. Lower Silurian (Llandeilo).

Neobolus, Waagen. 1885.

Shell oboloid, with a somewhat transverse, slightly thickened posterior margin, which, in the pedicle-valve, is traversed by a broad, cross-striated pedicle-groove. The cardinal muscular scars lie close upon this groove; the central scars are faint, and in the figure, indistinctly defined, but are seen to abut against a short thickened ridge or knob in the middle of the shell. Marginal scars on both valves broad. In the brachial valve a strong longitudinally grooved callosity lies just within the cardinal margin, and this is more or less distinctly continued into a median septum. The arrangement of the muscular scars other than those referred to, is not fully understood.



Neobolus Warthi. After WAAGEN.
FIG. 250.—Interior of pedicle valve.
FIG. 251 — Interior of brachial valve.

Type, *Neobolus Warthi*, Waagen. Cambrian (India).

Spondylobolus, McCoy. 1852.

Shells subcircular, slightly narrowed towards the indistinct, short hinge-line; nearly equivalve, flattened. Small valve, with a slightly excentric apex; beneath which, on the interior, the substance of the valve is thickened into a wide, undefined boss. Opposite valve slightly longer, from the apex being perfectly marginal and slightly produced; channeled by a narrow, triangular groove below, the anterior end of which is flanked by two very prominent thick, conical, shelly bosses, representing hinge-teeth; substance of the valve thick, testaceous, not glossy, minutely fibrous, but not distinctly punc-

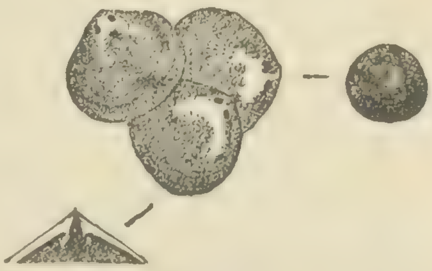


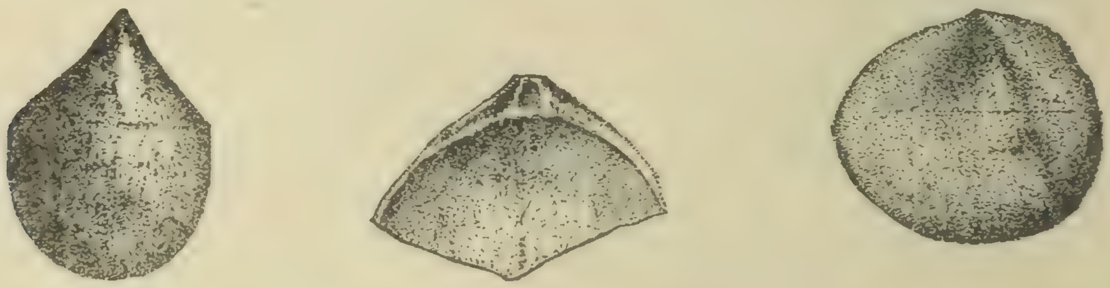
FIG. 252 —*Spondylobolus craniolaris.* After McCOY.

tated under a lens of moderate power, except by the ends of these fibers.

Type, *Spondylobolus craniolaris*, McCoy. Lower Silurian (Llandeilo).

Mickwitzia, Schmidt. 1888.

Shells large, thick, inequivalve. Brachial valve flat, circular; pedicle-valve oval, convex, produced into an acute apex, beneath which lies a triangular, more or less distinctly developed cardinal area. Valves not (?) articulated. Shell-substance composed of thin, coarsely punctate layers alternating with prismatic laminæ which are traversed by scattered vertical canals. Surface covered with radiating striæ. Shell composed of calcic phosphate.



Mickwitzia monilifera. (After SCHMIDT)

FIG. 253.—Pedicle-valve. FIG. 254.—Interior of same valve. FIG. 255.—Exterior of brachial valve.

Type, *M. monilifera*, Linnarsson. Lower Cambrian.

Schizobolus, Ulrich. 1886.

(Plate 3, Figs. 16–19.)

Shell oval, slightly inequivalved; cardinal margins somewhat thickened. Shell substance largely corneous; external surface concentrically lined. In the pedicle-valve, the passage is very short, usually no more than a notch on the margin. From its inner end a median ridge extends one-third the distance across the valve, and this is flanked on each side by a low muscular callosity. Narrow curved lateral scars extend from the post-lateral margins of this callosity, continuing to, or beyond the center of the valve. In the brachial valve is a narrow thickened band directly within, and parallel to the posterior margin. Muscular thickening as in the opposite valve. No curved lateral scars.

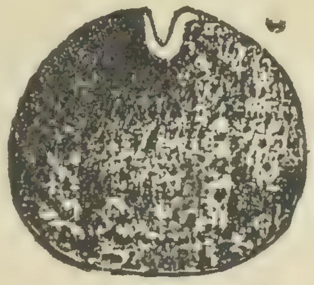
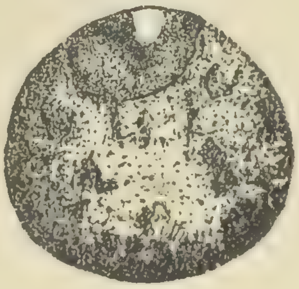
Type, *Schizobolus truncatus*, Hall (sp.). Devonian.

A single species has been described; from the Genesee shales.

Discinolepis, Waagen. 1885.

Shell of very small size with two unequal valves, which are very flat, leaving scarcely any room for the animal between them.

The pedicle-valve depressed convex, the apex only being a little elevated and removed from the margin towards the median part of the valve. The posterior margin of the valve near the apex is broadly notched by a deep incision reaching to the beak.



Discinolepis granulata.
After WAAGEN.
FIG. 256.—Pedicle-valve. FIG. 257—Brachial-valve.

The brachial valve is similar in shape to the other, with a slightly elevated eccentric apex, but without an incision.

The surface in both valves is either smooth or finely granulose.

Type, *Discinolepis granulata*, Waagen. Cambrian (India).

Paterina, Beecher. 1891.

Valves semi-elliptical in outline, subequal, the pedicle-valve being slightly the more elevated. Hinge line equal to the greatest width of the shell, without cardinal area. Pedicle passage not limited except by the posterior margins of the valves.

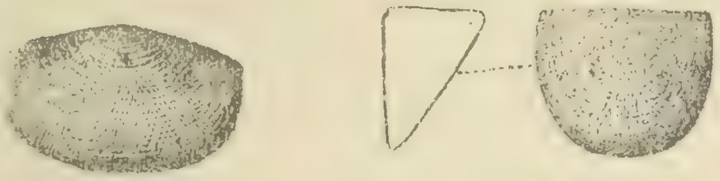


FIG. 258.—*Paterina Labradorica.* (WALCOTT.)

External surface covered with concentric lines terminating abruptly on the cardinal margin. Shell substance corneous.

Type, *Paterina Labradorica*, Billings (sp.). Cambrian. Only a single species of the genus is known.

Kutorgina, Billings. 1861.

(Plate 4, Figs. 11–13.)

Shells inequivalve, transverse or elongated. Hinge-line nearly equaling the greatest width of the shell. Pedicle-valve convex, greatly elevated at the beak, which is more or less incurved. Cardinal area very narrow, and divided by a wide pedicle-fissure. Brachial valve flat or slightly convex, beak marginal. Cardinal area very feebly developed. The posterior portion of the valves is therefore unclosed for nearly the entire length of the hinge-line.

External surface covered with concentric lines, which terminate abruptly at the cardinal line.

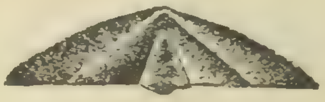
Shell substance calcareous.

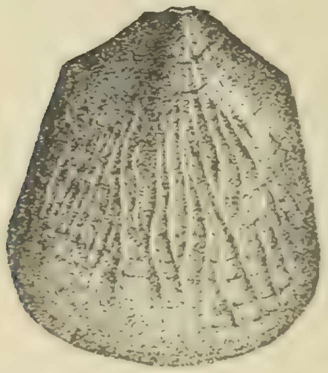
Type, *Kutorgina cingulata*, Billings. (Cambrian.)

A number of species from North America, Sweden and Great Britain have been referred to this genus, but it is doubtful if they are all congeneric. Some of them probably belong to PATERINA, Beecher, and others to SCHIZOPHOLIS, Waagen.

Schizopholis, Waagen. 1885.

Shells of very small size. Pedicle-valve slightly elevated, with a somewhat prominent marginal apex, below which is a small triangular area, crossed in the middle by a triangular fissure, a little widened at the top, forming a kind of foramen, placed just at the extremity of the apex. Brachial valve flat, imperforate.





Schizopholis rugosa. Pedicle-valve. After WAAGEN.
FIG. 259.— Upper view.
FIG. 260.— Cardinal view.

Shell surface finely granular.

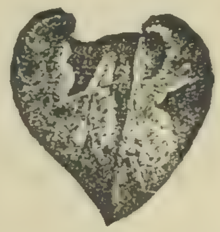
Of the internal characters of the genus nothing is known.

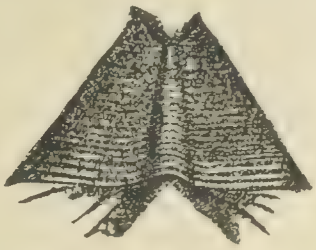
Type, *Schizopholis rugosa*, Waagen.

Distribution. Cambrian (India: North America, *S. Latourensis*, Matthew (sp.); *S. pannula*, White (sp.).

Volborthia, von Möller. 1873.

Shell convex, very inequivalve; contour as in KUTORGINA. Pedicle-valve elevated, incurved at the apex, and with a broad, sharply defined cardinal area, divided by a low convex ridge passing from the beak to the cardinal margin. There is no foramen.





Volborthia recurva. After VON MÖLLER.
FIG. 261.—Profile. FIG. 262 —Cardinal view.

Brachial valve convex; beak marginal; cardinal area not developed. Muscular impressions not known. Surface covered with concentric lines. Shell substance calcareo-corneous.

Type, *Volborthia recurva*, Kutorga (sp.). Lower Silurian.

Iphidea, Billings. 1872.

(Plate 4, Figs. 4, 5.)

Pedical-valve subconical; beak apical. Hinge-line short, nearly straight. Cardinal slope flattened, forming an imperfectly defined area, which is divided medially by a convex ridge or pedicle-covering. Foramen circular, apical.

Brachial valve moderately convex; most elevated at the beak. Internal characters not known. External surface covered with cencentric striæ, which are continued over the area of the pedicle-valve. Shell substance corneous.

Type, *Iphidea bella*, Billings.

Distribution. Cambrian (Newfoundland, Vermont, Arizona, Sweden).

Acrothele, Linnarsson. 1876.

(Plate 3, Figs. 24–27.)

Shell corneous, composed of several laminæ. Pedicle-valve slightly conical, with excentric umbone, pierced by a minute foramen, in front of which there are two small wart-like protuberances; the area between the umbone and the posterior margin is usually a little flattened. Brachial valve with marginal umbone; in the interior of which there are two oblong, diverging muscular scars, close to the posterior margin, and two small rounded scars near the middle. The muscular scars are separated by a longitudinal ridge.

Type, *Acrothele coriacea*, Linnarsson.

Distribution. Cambrian — Lower Silurian (New Brunswick, Utah, Ireland, Bohemia, Sweden).

Acrotreta, Kutorga. 1888.

(Plate 3, Figs. 28–30.)

Pedicle-valve subconical, the posterior slope being flattened, having a triangular form and resembling a cardinal area. This slope is divided medially by a groove, widening downward; at the apex of the valve is a circular foramen. On the interior this foramen penetrates a mammiform callosity.

Brachial valve flat or depressed convex; apex marginal; on the interior is a stout median ridge flanked by a large anterior and a smaller posterior pair of muscular impressions.

Exterior concentrically striated. Shell substance corneous.

Type, *Acrotreta subconica*, Kutorga.

Distribution, Cambrian — (?) Lower Silurian.

Conotreta, Walcott. 1888.

(Plate 4, figs. 1–3.)

Synonym; *Geinitzia*, Hall. 1889.

Pedicle-valve conical, its height being greater than its length; apex with evidence of the external opening of the sipho. From the apex, a shallow furrow extends to the posterior margin, increasing in width downward. In young shells the posterior wall of the shell conforms to the curvature of the rest of the surface, interrupted only by the longitudinal depression, but, with increase in size, this area becomes distinctly flattened as in ACROTRETA. Surface covered with sharp concentric striæ which make a slight upward curve as they cross the foraminal groove.

On the interior a strong apical callosity surrounds the probable position of the foramen. This is somewhat produced anteriorly into a short, sharp ridge, on either side of which lie two other ridges, with evidence of a third on the lateral slopes.

Type, *Conotreta Rusti*, Walcott. (Lower Silurian.)

The single species described occurs in the Trenton limestone of New York and the Utica slate of Kentucky.

Discinopsis, Matthew. 1892.

(Plate 3, Figs. 20, 21.)

Shell subcircular in outline. Surface depressed-conical, apices excentric, not marginal. Pedicle-valve with the apex truncated by a circular foraminal aperture (?). The interior of this valve is characterized by a pair of deep, diverging furrows, passing forward from the beak or internal foraminal opening, in broad curves which converge toward the anterior margin but without meeting. These furrows inclose a thickened and somewhat elevated central area, which, in the subumbonal region, is apparently free, projecting for a short distance, like a narrow, triangular shelf, beneath which the foramen probably opened. A faint longitudinal ridge passes from the apex of the shelf to the anterior margin.

Shell-substance tenuous, apparently corneous. External surface covered with more or less prominent, sometimes lamellose concentric growth-lines, crossed by fine, gently curved, radiating striæ which are usually more prominent when the concentric lines are exfoliated.

Type, *Discinopsis Gulielmi*, Matthew. (Cambrian.)

A single species from the St. John group of New Brunswick.

Linnarssonia, Walcott. 1885.

(Plate 3, Figs. 22, 23.)

Shells transversely ovate or subcircular; valves convex. Pedicle-valve with somewhat elevated submarginal apex, perforated by a circular foramen; without cardinal area or thickened cardinal margin. On the interior there is a conspicuous mammiform tubercle surrounding the opening of the foramen, and two small posterior submarginal tubercles.

In the brachial valve are similar tubercles, though less conspicuously developed; between them lies an axial ridge which is broadened over the central portion of the shell; at the sides are shorter, divergent ridges.

Shell substance calcareo-corneous; lamellar. Surface smooth or with concentric growth-lines.

Type, *Linnarssonia transversa*, Hartt (sp.).

Distribution. Cambrian—(?), Lower Silurian (New York, New Brunswick, Canada, Sweden, Wales).

Mesotreta, Kutorga. 1848.

(Plate 4, Fig. 21.)

Shell patelliform, depressed-conical; apex central, perforated by a foramen; no cardinal area or flattening (?). Surface ornamented by concentric growth-lines bearing spines. Pedicle-valve only known.

Type, *Mesotreta tentorium*, Kutorga (Lower Silurian. Russia.).

Trematobolus, Matthew. 1893.

Shell biconvex; valves lenticular. Pedicle-valve with a low, striated hinge-area, the anterior margin of which bears two small articulating apophyses or teeth. Foramen in the center of the shell, opening obliquely backward; between it and the apex is a long tapering groove, with a corresponding ridge on the interior. Muscular scars submarginal, divisible into a posterior and anterior pair.

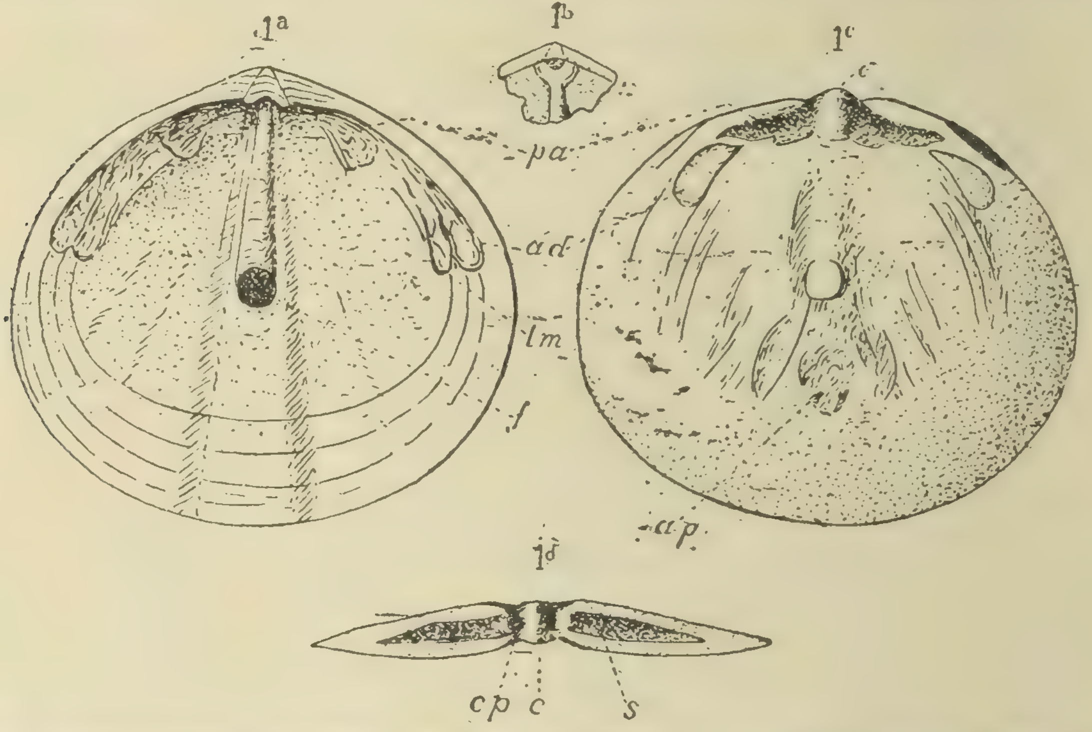


FIG. 263.– *Trematobolus insignis.* 1*a*, interior of pedicle-valve; 1*b*, internal cast of brachial valve; 1c, cardinal view of brachial valve; 1*d*, inside of beak of pedicle-valve; *pa*, posterior adductors: *ad*, adjustors; *lm*, lateral muscles; *t*, teeth; *f*, foramen; *s*, sockets; *c*, cardinal process; *cp*, cardinal pits. (MATTHEW.)

Brachial valve, with long, narrow dental sockets and distinct cardinal process. Anterior and posterior muscular scars submarginal and less remote than in the opposite valve.

Surface covered with fine concentric growth-lines and faint traces of radial striæ.

Shell substance calcareo-corneous (?)

Type, *Trematobolus insignis*, Matthew.

Distribution. St. John group: Hanford Brook, New Brunswick.

Siphonotreta, de Verneuil. 1845.

(Plate 4, Figs. 22–26.)

Shell elongate-oval, inequivalve; valves unarticulated. Pedicle-valve the more convex, with a straight, elevated, conical, and perforated beak, the circular foramen opening at the apex and communicating with the interior of the shell by a tubular canal, which narrows slightly as it passes inward. No cardinal area or deltidium is present, the growth-lines passing between the beak and the posterior margin as elsewhere on the shell. Brachial valve depressed-convex; beak marginal; posterior margin regularly arched and thickened. Interior of pedicle-valve with muscular impressions confined to the umbonal region. Adjacent to the opening of the sipho, and just within the cardinal margin lie two elongate scars which are accompanied on either side by broader, somewhat expanded or flabellate, simple and less distinct impressions. Directly in front of the middle pair and in the axis of the shell lies a small central scar, and at either side of it a transversely elongate impression. These latter impressions are distinctly separated from the former by a transverse ridge.

In the brachial valve the impressions are equally concentrated, the entire muscular area being bounded on its posterior margin by a prominent ridge which, at the sides, merges into a compound lateral scar. The central portion of the area is much depressed and is divided axially by a narrow ridge or septum.

Shell ornamented with concentric lines and ridges, the epidermal layer bearing hollow spines, which are distended at the base. Shell-substance calcareo-corneous, the layers beneath the epidermis being punctured by radiating and branching tubules. These layers are concentric and not parallel to the internal surface.

Type, *Siphonotreta unguiculata*, Eichwald.

Distribution. Lower — Upper Silurian (Baltic Provinces, England, Scotland, New York, Minnesota).

Schizambon, Walcott. 1884.

(Plate 4, Figs. 16–20.)

Shell ovate or oblong; pedicle-valve the more convex, with a short obtuse marginal beak. Foramen in front of the beak, oval in outline and connected with the apex by a tapering groove or progressive cicatrix. Interior of both valves with faint diverging lateral ridges indicative of muscular areas.

Surface covered with concentric growth lines which may be spiniferous. Shell substance calcareo-corneous.

Type, *Schizambon typicalis*, Walcott. (Lowest Silurian [Primordial ?]).

Species having the pedicle-passage situated anteriorly as in *S. typicalis*, but having it developed as a tube, as in SIPHONOTRETA, have been referred provisionally to SCHIZAMBON (*S. fissus*, Kutorga, *S. Canadensis*, Ami). These are much larger and more strongly spinose shells than *S. typicalis*, and also occur in faunas of later age. (Trenton.)

Helmersenia, Pander. 1861.

(Plate 4, Figs. 6, 7.)

Shell having the general form of OBOLUS, with a conspicuous cardinal area depressed in the center by a broad low pedicle-groove (?). Apex of the pedicle-valve truncated by a circular opening, which is not produced into an internal tube. Muscular impressions indistinct.

No specific name has been proposed for the typical form. (Lower Silurian of Russia.)

Orbicella, D'Orbigny. 1849 (1847 ?).

(Plate 4, Figs. 8–10.)

Synonym; *Keyserlingia*, Pander. 1861.

Shell inequivalve, subcircular or oval. Pedicle-valve more or less conical with an excentric apex, from which diverge posteriorly two low ridges inclosing a flattened triangular area divided in the center by a vertical fissure. The lines of growth cross the hinge-line, forming in the center a faintly depressed triangular groove, as in HELMERSENIA and OBOLUS. In the interior of the valve a closed tube is continued from the external fissure, in the axial line. The first one-third of this tube is swollen and thickened, but thenceforward it passes, with parallel sides, to the anterior margins, where it is probably closed. Brachial valve more depressed, its greatest convexity being in the center. Cardinal area as in the opposite valve, but narrower. A closed tube, beginning in a swelling just in front of the cardinal line, is continued from the center of the shell to the anterior margin as an open channel.

Type. *Orbicella Buchi*, de Verneuil (sp.). (Lower Silurian of Russia.)

Discinisca, Dall. 1871.

Synonym; *Discina*, of most authors.

Shells orbicular; brachial valve the more convex; pedicle-valve more or less flattened, concave or depressed. Apices of both subcentral or subposterior. Pedicle-valve with a small septum as in DISCINA, behind which is an impressed disc or area, externally concave and internally elevated. This is perforated by a longitudinal fissure, extending from a short distance behind the septum nearly to the posterior margin, which is often slightly indented behind it. Shell more or less horny in texture, minutely tubulose. Brown or yellowish in color. Animal with labial folds united. Spiral arms free, their apices being directed toward the pedicle-valve. Oral cirri long and flexible; setæ of the mantle stiff and brittle. Adductor muscles, four; sliding-muscles also four.

Type. *Discinisca lamellosa*, Broderip (sp.).

Distribution. American seas (Atlantic, Pacific, Carribean), China. Fossil: Mesozoic (?) to Tertiary.

Discina, Lamarck. 1819.

Synonym, *Orbicula*, Sowerby. 1818 (not Cuvier. 1798).

Shell orbicular, calcareo-corneous, thick, impunctate, lamellar. Valves convex. A small, sharp, longitudinal septum rises from the center of the lower or pedicle-valve, of a subtriangular shape, covering and hiding a small tubular perforation of the apex of the shell. This perforation is very oblique, and from its internal opening a groove extends backward nearly half-way to the posterior border of the shell. The anterior muscular scars meet in front of the septum and form a semilunar elevation with the points directed backward. The posterior scars in the lower valve are small and widely separated. On the external surface the foramen appears nearly in the middle of the shell and the furrow is continued anteriorly for a short distance. Upper or brachial valve convex, apex subcentral; a slight median longitudinal callus internally. There is no strongly impressed disk about the foramen as in DISCINISCA; color brownish yellow.

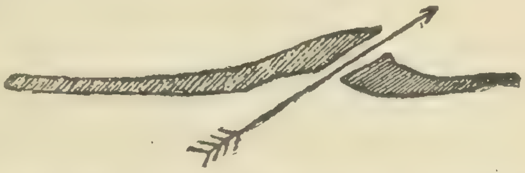


FIG. 264.—Vertical section of the pedicle-valve of *Discina striata*. After DAVIDSON.

Type, *Discina striata*, Schumacher.

Habitat. Cape Palmas, West Africa. (Recent; but one species known.)

Orbiculoidea, D'Orbigny. 1847.

(Plate 5, Figs. 11–17.)

Synonym; *Discina* of authors. Not *Orbiculoidea*, Davidson. 1856.

Shells subcircular or subelliptical in outline, inequivalve. Apices excentric. Pedicle-valve depressed-convex or flattened, with the apex slightly elevated and inclined posteriorly. On the exterior of the valve a narrow pedicle-furrow, abruptly intercepting the ornamentation but not penetrating the substance of the shell, begins just below and behind the apex, extends over a greater or less portion of the radius of the valve, and, at its distal end, is produced into a short tubular sipho, which traverses the substance of the shell obliquely backward, emerging on the interior surface, where it produces a narrow groove, and usually terminates before reaching the margin of the valve. On the interior, the position of the external groove is marked by a thickened ridge extending from the apex, and this is continuous with the thickened margins of the internal groove, which, in advanced age, may become so developed as to envelop this groove, except at its outer end.

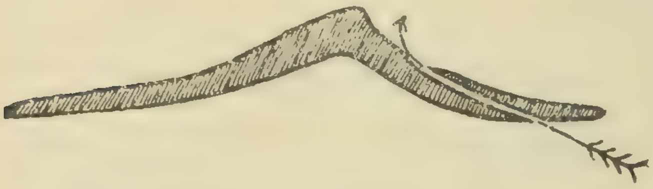


FIG. 265 — Vertical section of the pedicle-valve of *Orbiculoidea*.

The larger or brachial valve is depressed-conical, with the apex more strongly directed backward than in the opposite valve. The interior shows a fine longitudinal ridge or septum extending from the apex forward. Otherwise the internal markings are not satisfactorily known.

Shell substance composed of alternating lamellæ of corneous and mineral matter, the latter often removed in fossilization, making the shell appear essentially phosphatic. Surface ornamentation usually consisting of fine, crowded or distant, sometimes lamellose, concentric lines, occasionally crossed by radiating lines or ridges.

Type, *Orbicula Morrisi*, Davidson. (Wenlock limestone.)

Distribution. Lower Silurian — Cretaceous (?).

Subgenus **Schizotreta,** Kutorga. 1848.

(Plate 5, Figs. 1–4.)

Shells as in *Orbiculoidea* but having the relative convexity of the valves reversed, the pedicle-valve being the more convex.

Type, *Schizotreta elliptica*, Kutorga. (Lower and upper Silurian.)

Subgenus **Rœmerella,** Hall. 1892.

(Plate 5, Figs. 9, 10.)

Brachial valve convex; pedicle-valve concave.

Type, *Rœmerella grandis*, Vanuxem (sp.) (Hamilton group = Middle Devonian.)

Subgenus **Œhlertella,** Hall. 1892.

(Plate 5, Figs. 5–8.)

Contour as in ORBICULOIDEA. Attachment aided by the projecting margin of the brachial valve. Pedicle-area conspicuously elevated; pedicle-passage an open fissure extending to the margin of the valve. Floor of the pedicle-passage (listrium) tripartite. Muscular scars not observed. External surface covered with concentric striæ.

Type, *Œhlertella pleurites*, Meek (sp.) (Waverly sandstone = lower Carboniferous.)

Subgenus **Lindstrœmella,** Hall. 1892.

(Plate 5, Figs. 18, 19.)

Shells with outline, contour and pedicle-characters as in ORBICULOIDEA. Brachial valve with a faint median septum and two strong approximiting ridges or muscular fulcra, beginning just behind a transverse line passing through the apex and rapidly converging to meet the median septum. Anterior adductor scars lying between these ridges and the median septum; a circular muscular scar at the posterior extremity of each ridge.

In the pedicle-valve, the foramen has essentially the structure of ORBICULOIDEA, but its distal margins, though lying in close juxtaposition, appear not to have been united.

Type, *Lindstrœmella aspidium*, Hall. (Hamilton group = middle Devonian).

Trematis, Sharpe. 1847.

(Plate 6, Figs. 1–8.)

Shell subcircular or transversely oval in outline. Pedicle-valve unevenly convex, more or less depressed over the posterior region; apex at, or behind the center; directly beneath it begins the pedicle-fissure, which transects the shell, vertically widening to posterior margin with straight or outwardly curving edges. Brachial valve evenly convex, with its apex marginal and slightly projecting. On the interior, the pedicle-valve shows a faint median furrow extending from the angle of the fissure to the apex of the shell: this groove widens at its apical termination and may represent a point of muscular attachment. The sides of the fissure are often thickened by callosities similar to those sometimes seen in species of ORBICULOIDEA. From the apex of the valve extend radiating and branching vascular sinuses.

In the brachial valve the posterior margin is much thickened and broadly grooved to allow the extrusion of the pedicle. This thickening does not take the form of a cardinal area or shelf, but is rather a callosity closely appressed against the interior surface of the shell, the central portion being projected beyond the margin of the pedicle-valve. Directly below and in front of this area are two transversely elongate scars, adjustors or posterior adductors, which are usually partly concealed by the progressive overgrowth of the cardinal thickening. A faint median septum begins between these scars and passes forward, becoming more prominent over the tongue-shaped median elevation which separates the large central scars. These impressions are oblique and are not simple, each appearing to be composed of two, if not three distinct scars, making a posterior, a median and an anterior pair. What appears to be the posterior pair is small, and sometimes quite sharply defined, the central pair very much larger, and the anterior pair narrow, situated at either side of the angle of the median callosity and separated by its apex. The specialization of the first of these scars is not satisfactorily established; the entire impression is deeply excavated. In some well preserved specimens, there is also evidence of external, marginal scars lying just in front of the outer ends of the posterior adductors.

Surface of both valves more or less completely covered by a beautiful ornamentation consisting of punctures or small pittings of various depth, arranged either in quincunx (*T. terminalis*) or in radiating rows; in the latter case they may be distant from one another without intervening ridges (*T. umbonata*), or lie in radiating furrows, when they are either circular (*T. millepunctata*) or subrectangular (*T. Ottawensis*).

Shell-substance composed of an outer calcareous layer with a series of inner corneous lamellæ. The outer layer varies in thickness in different species, and is coarsely punctated by the pittings constituting the surface ornamentation. The corneous layers are impunctate.

Type, *Trematis terminalis*, Emmons (sp.).

Distribution, Lower (to upper?) Silurian.

The species are largely American and mainly confined to the faunas of the Trenton and Hudson River groups.

Schizocrania, Hall and Whitfield. 1875.

(Plate 6, Figs. 9–13.)

Shells sub-circular in outline, inequivalve, unarticulated. Pedicle-valve flat or concave; apex subcentral. A deep triangular notch extends from just behind the beak to the margin, where its arc is equal to about one-sixth of the periphery. The apex of this broad pedicle-notch is occupied by a triangular transverse plate or listrium varying in size with the age of the shell, but extending for one-fourth to one-third the length of the opening. Surface marked by concentric growth-lines. On the interior no muscular impressions are visible. Brachial valve more or less convex, with the beak marginal. External surface radiately striated. The interior bears a pair of strong posterior adductor scars, lying close together in the unbonal region; their outline is elongate-ovate, indicating a progressive increase in size, and they frequently appear to be divisible into anterior and posterior elements. In front of them, at about the center of the valve, are the small and faint anterior adductor impressions. A low median ridge extends from the apex to beyond the center of the valve. External surface marked by elevated striæ radiating from the beak.

Substance of the shell composed of perlaceous calcareous laminæ which constitute the most of the shell. The inner layers appear to be corneous. All are impunctate (?).

Type, *Schizocrania filosa*, Hall.

Distribution. Lower Silurian to (?) Devonian. The genus is American and the typical species are found in the fauna of the Hudson River group.

Crania, Retzius. 1781.

(Plate 6, Figs. 14-23,)

Synonyms. *Numulus*, Stobœus, 1732; Waller, 1778; *Anomia*, Linné, 1760; *Ostracites*, Beuth, 1776; *Patella*, Müller, 1776; *Criopus*, *Criopoderma*, Poli, 1791, 1795; *Orbicula*, Cuvier, 1798; Lamarck, 1799; *Orbicularius*, Duméril, 1806; *Craniolites*, Schlotheim, 1820; *Choniopora*, Schauroth, 1854.

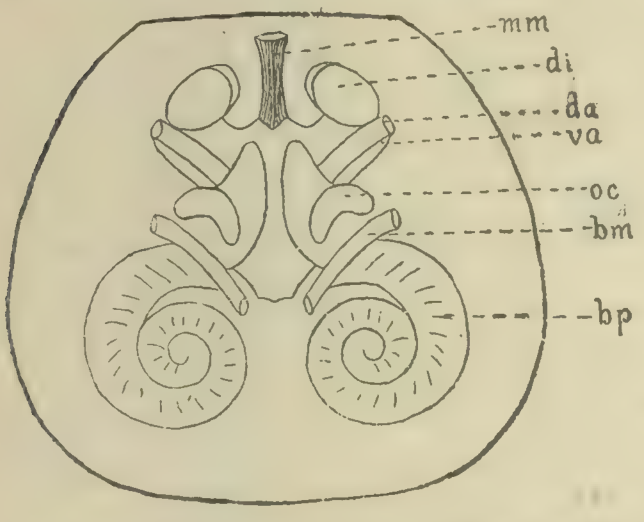
Shell inequivalve, inarticulated, without perforation for a pedicle: subcircular in outline, generally somewhat transverse across the posterior margin: attached by the apex or the entire surface of the lower valve. Ventral or lower valve depressed-conical or conforming to the surface to which it is attached. Dorsal or upper valve more or less conical with a subcentral, posteriorly directed apex. External surface of the valves usually smooth, sometimes spinose or with concentric or radiating striæ. In the interior of both valves are two pairs of large adductor scars, the posterior of which are close upon the margin and widely separated, the anterior near the center of the shell and close together, more approximate in the lower than in the upper valve. These posterior scars are often strongly elevated on a central callosity which surrounds their broad and thickened margins. Impressions of the pallial genital canals anterior. The margin of the lower valve is usually coarsely digitate.

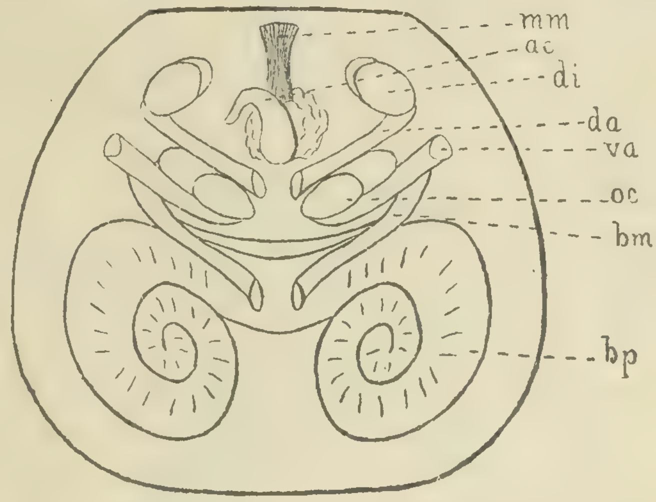
Shell-substance calcareous: strongly punctated by vertical canals which become subdivided toward the epiderma lsurface.

Animal provided with two spiral arms, whose apices are directed toward the dorsal valve. The alimentary canal forms a convolution on the right side, the anus opening near the center of the ventral valve. Liver large: genital glands six in number, two in each mantle lobe and two in the visceral cavity. Mantle without marginal setæ.

Type, *Crania craniolaris.* Linné.

Distribution. Lower Silurian to Recent (Northern Atlantic, Mediterranean, Caribbean, Florida, Japan).





Crania anomala. After HANCOCK.

FIG. 266.—Dorsal surface of the animal. FIG. 267.—Ventral surface.

mm, mesenteric muscle; *di*, divaricators; *da*, dorsal adjustors; *va*, ventral adjustors; *oc*, occlusors: *bm*, brachial muscles; *bp*, brachial process; *ac*, alimentary canal (According to JOUBIN, this organ should have a median, not lateral termination).

Subgenus **Ancistrocrania,** Dall. 1877.

(Plate 7, Figs. 1, 2.)

(Synonym; *Cranopsis*, Dall. 1871.)

Lower valve attached; upper valve with two internal apophyses or muscular fulcra diverging from the apex.

Type, *Ancistrocrania Parisiensis*, Defrance (sp.). Cretaceous.

Subgenus **Craniscus,** Dall. 1871.

(Plate 7, Fig. 3.)

(Synonym; *Siphonaria*, Quenstedt. 1851.)

Attached valve divided by a transverse and a longitudinal septum into three cells, the posterior containing the muscular impressions.

Type, *Craniscus tripartitus*, Münster (sp.). Jurassic.

? Subgenus **Pseudocrania,** McCoy. 1851.

(Plate 7, Figs. 11–13.)

(Synonym; *Palæocrania*, Eichwald. 1860.)

Shell free; valves convex; margins of contact broad and flat; upper valve with three pairs of muscular scars, the largest submarginal; a smaller median pair, and an anterior pair with the members in apposition. In the lower valve the median and anterior scars are coalesced; the cardinal scars as in the other valve.

Type. *Pseudocrania antiquissima*, Eichwald (sp.). (Lower Silurian.)

Subgenus **Craniella**, Œhlert. 1888

(Plate 7, Figs. 4, 8.)

Shell somewhat irregular, outline subcircular or subquadrangular. Lower valve thin, adhering by its entire surface; upper valve conoidal, more or less elevated; apex subcentral, posterior: interior of the upper valve without a well defined border; impressions of the adductors large, very distinct, four in number, of which the posterior two are quite distant, the anterior two subcentral, somewhat smaller, closely approximate or even confluent; from near each of the posterior impressions starts a vascular sinus, which is broad, strongly sinuous near its point of departure, narrowing gradually in following the contour of the valve, emitting from its marginal side dichotomizing secondary branches.

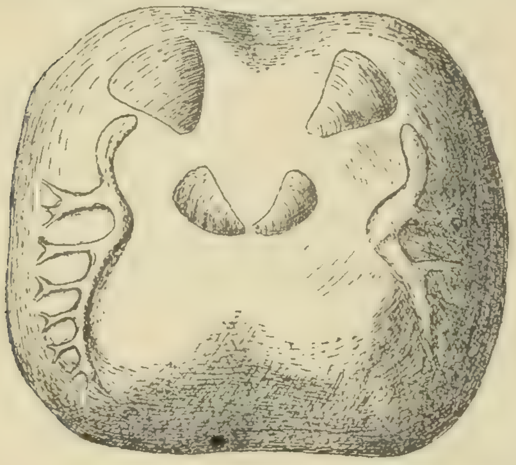


FIG. 268.—*Craniella Meduanensis*. After ŒHLERT. Internal cast of upper valve.

Type, *Craniella Meduanensis*, Œhlert.

Distribution. Lower Silurian to Devonian.

Subgenus **Cardinocrania**, Waagen. 1885.

(Plate 7, Figs. 9, 10.)

Shells attached; posterior margin straight, set off from the rest of the outline by strong post-lateral indentations. Interior with a thin triangular plate, broad at its base where attached in the cardinal region; supported by a low median septum. Muscular impressions unknown.

Type, *Cardinocrania Indica*, Waagen. (Permo-carboniferous, India.)

Pholidops, Hall. 1859.

(Plate 7, Figs. 14–22.)

Synonyms; *Patellites*, Schlotheim, 1820; *Craniops*, Hall. 1859.

Shells small, patelliform, equivalve, equiconvex, inarticulate, unattached. Outline oval or subelliptical; apex subcentral, excentric or marginal, sometimes terminal and produced. Surface marked by strong concentric, often lamellose lines of growth, which are crowded on the posterior, and distant on the anterior portions of the valves; these are sometimes crossed by faint interrupted radiating lines. On the interior, the surfaces of contact make a broad, smooth, flat or slightly convex border, somewhat broader in front than behind. The muscular and visceral area occupies a sharply defined and very limited space in the apical portion of each valve. In both valves it is of essentially the same size and ovate-triangular in outline, the apex of the triangle pointing forward and usually surrounded by a conspicuous callosity.

The ventral (?) valve bears two well defined central adductors occupying the same relative position as in CRANIA; these impressions are usually simple, but appear to be sometimes complicated by association with ill-defined scars of the anterior muscles. The posterior adductors or divaricators are situated at the basal angles of the muscular triangle, and are distant from the posterior margin. The linear parietal scars are very strong, the posterior being more or less distinctly lobate, the anterior generally straight or rounding about the central adductors. In the opposite or dorsal (?) valve the scars have essentially the same arrangement; the anterior adductors, however, are separated by elongate median scars (anteriors) which traverse the elevated callosity surrounding the anterior margin of the area. The posterior scars are often more widely divergent than in the other valve. Shell-substance calcareous and impunctate (?).

Type, *Pholidops squamiformis*, Hall.

Distribution, Lower Silurian to Lower Carboniferous.

II.

Brachiopoda Articulata.

Valves articulated; intestine terminating in a blind sac; shell-substance essentially calcareous.

So far as our knowledge of the fossil species extends, there are very few of the forms included in this division to which the above definition does not apply. Several genera show very considerable modification of the articulating apparatus, but with rare exceptions these modifications in each group appear to be progressive, extending along certain lines of development and finally acquiring an extravagant manifestation, which may terminate abruptly or be followed by the degeneration and obsolescence of some of the parts.

For example, the articulating apparatus in STROPHEODONTA, PRODUCTUS, etc., may be regarded as in a degenerative condition, and on this account these genera are sometimes placed near the base of the articulate division, though the type of structure exhibited by them is much more highly modified than in ORTHIS and its immediate allies in the older rocks.

The mode of articulation in PRODUCTUS appears to have come legitimately from the progress and development of some portions of the articulating apparatus on the one hand, and the obsolescence of other characters, which appear in the earlier forms of strophomenoid shells, and have become modified in their progress through the chonetids. While this may be regarded as a degeneration, it is also a progressive modification.

Of the various designations which have been proposed with a signification equivalent to Professor HUXLEY's term for this subdivision of the BRACHIOPODA, are ARTHROPOMATA, OWEN; CLISTENTERATA, KING; while BRONN made use of the two names TESTICARDINES and APYGIA.

Orthis, Dalman. 1828.

(Plates 9–12.)

Synonyms: *Hysterolithes*, Schlotheim, 1820; *Orthambonites*, Pander, 1830.

Shell subcircular, subovate or subquadrate in outline. Valves more or less convex, the smaller or brachial valve being sometimes nearly flat or slightly concave. Hinge-line straight and equal to, or shorter than the greatest width of the shell. Cardinal area well developed on each valve and usually divided by an open triangular delthyrium. Beaks more or less incurved. Surface covered by radiating costæ or fine striæ, with faint evidence of median fold and sinus.

In the interior of the pedicle-valve the large hinge-teeth are supported by dental plates which are more or less conspicuously developed, frequently resting upon the bottom of the valve. The bases of these are continued as a low elevation about the muscular area. This muscular impression is divided longitudinally by an inconspicuous median ridge and the larger expansions on each side were probably occupied by the diductor muscles; within these and lying close against the median ridge are the adductors, while the pedicle muscles covered the posterior deltidial portion of this area.

In the interior of the brachial valve the apex of the deltidial cavity bears a more or less developed cardinal process or callosity, which, in the typical group, is elongate and usually simple at its termination. The dental sockets are deep and their inner walls support short divergent crura. The muscular impression is more or less distinctly quadruple, being divided longitudinally by a median ridge extending forward from the cardinal process, and transversely by fainter ridges. This quadruple scar marks the place of attachment of the adductor muscle.

Ramified vascular markings are often retained over the pallial area, the principal trunks diverging from the median region and nearly following the curve of the anterior margin of the shell. Between these and the adductor impressions the markings of the ovarian areas are sometimes visible.

Shell-structure fibrous and impunctate in the typical group.

This extensive genus has been divided into the following groups or subgenera:

Orthis, Dalman, *sensu stricto.*

I. Group of ORTHIS CALLACTIS, Dalman.

(Plate 9, Figs, 1–7.)

Shells plano-convex in contour; costæ, strong, sharp and comparatively few, rarely if ever bifurcating; the cardinal area on the pedicle-valve elevated and somewhat incurved; dental lamellæ slightly developed, not extending the entire length of the umbonal cavity. The cardinal process on the brachial valve is an elongate, vertical plate, extending from the apex the whole length of the delthyrium, thus longitudinally dividing the deep deltidial cavity. It is usually simple, both on the outer edge and at its distal extremity. Shell structure compactly fibrous and impunctate, except for large oblique tubules penetrating the external layers. (Lower — Upper Silurian.)

Plectorthis, Hall. 1892.

II. Group of ORTHIS PLICATELLA, Hall.

(Plate 9, Figs. 8–10.)

Valves subequally convex. Cardinal area of pedicle-valve low; plications strong, simple or duplicate. Shell substance impunctate. (Lower Silurian — (?) Lower Devonian.)

Dinorthis, Hall. 1892.

III. Group of ORTHIS PECTINELLA (Conrad, MS.), Emmons.

(Plate 9, Figs. 11–15.)

Relative convexity of the valves reversed. Surface with strong, rarely bifurcating plications. Delthyrium sometimes partially closed. Muscular area in pedicle-valve subquadrate, bounded by extensions of the dental lamellæ. In the brachial valve the muscular impressions are obscure; cardinal process erect, broad and frequently bilobed on its posterior face. Shell structure impunctate. (Lower Silurian.)

Plæsiomys, Hall. 1892.

IV. Group of ORTHIS SUBQUADRATA, Hall.

(Plate 9, Figs. 16–20.)

Valves with reversed convexity. In the interior of the pedicle-valve there is a large quadrate muscular scar, with a tendency to bilobation by the lateral extension of the diductor impressions. The subdivision of this area into separate scars is frequently very distinct. In the brachial valve the cardinal process is thickened and erect at its posterior extremity, being distinctly crenulate on the summit and posterior face. The surface striæ are tubulose and the shell-structure fibrous-impunctate. (Lower Silurian.)

Hebertella, Hall. 1892.

V. Group of ORTHIS SINUATA, Hall.

(Plate 10, Figs. 1–4.)

Shells with convexity of the valves reversed. Surface covered with numerous fine, rounded, closely-crowded plications, crossed by lamellose growth-lines. On the interior of the pedicle-valve the teeth are large and supported by thick lamellæ which are continued as a strong ridge around a short obcordate muscular area. This area is medially divided by a prominent ridge upon the summit of which lies the linear scar of the adductors. The flabellate lateral impressions are sometimes divisible into their two components, diductors and adjustors, and in old individuals the impression of the pedicle-muscle is often distinct.

In the brachial valve the dental sockets are narrow and are inclosed beneath, and on the inner side, by the strong crural plates. The cardinal process is elongate and simple, sometimes thickened, often crenulate, but not lobed at its posterior extremity. The process unites with the inner basis of the crural plates and is produced forward as a median ridge dividing the four muscular scars, which are distinctly developed only in old shells.

Shell-structure fibrous-impunctate: the plications of the surface sometimes tubulose.

(Lower — Upper Silurian.)

Orthostrophia, Hall. 1883.

VI. Group of ORTHIS STROPHOMENOIDES, Hall.

(Plate 10, Figs. 5–8.)

Contour and surface as in HEBERTELLA. In the interior of the pedicle-valve the muscular area is deeply excavated, and limited almost to the narrow space between the dental lamellæ. The adductor scars are extremely minute and linear, while the diductors occupy the rest of the area. In the opposite valve the muscular area is similarly confined but the quadrilobate character of the impression is very decided. The lateral components are divided by a strong median ridge, and the entire area is deeply impressed in the substance of the shell. The cardinal process is elongate and simple at its posterior extremity, the crural plates and crura strong.

The vascular and ovarian markings are conspicuous. In the pedicle-valve two or three large vascular trunks originate near the anterior edge of the muscular area, divide a few times in their passage over the pallial region, the branches rapidly multiplying near the margin. In the opposite valve the main sinuses are four in number, originating in pairs at the ante-lateral margins of the anterior adductors. The outer member of each pair curves quite abruptly toward the cardinal angle, while the inner members curve outward and then inward, all ramifying as they approach the margins of the shell. The umbo-lateral spaces inclosed by the curvature of these sinuses in both valves, and the central space in the brachial valve, are covered with linear dendritic ovarian striæ. Shell substance impunctate.

(Lower Devonian.)

Platystrophia, King. 1850.

VII. Group of ORTHIS BIFORATA, Schlotheim (sp.).

(Plate 10, Figs. 9–13.)

Contour spiriferoid; hinge-line and area long and straight, nearly equally developed on the two valves. Both valves very convex, the brachial being the more so, and bearing a very strong median fold corresponding to a deep sinus on the opposite valve. Surface of valves marked by strong, sharp plications, which extend over the fold and sinus, and the external surface is finely granulose, the latter feature being rarely well retained. Delthyrium open in both valves, being somewhat larger in the pedicle-valve, and in old and gibbous shells of *Orthis lynx* it has often encroached to a considerable extent upon the umbonal region of the valve. Teeth thick and very prominent; muscular area comparatively small, but usually deeply excavated in the substance of the shell, and not readily divisible into the component scars. The cardinal process of the brachial valve is a simple linear ridge, always small and sometimes nearly obsolete. Dental sockets comparatively small; crural plates large and thick, uniting at their inner bases and produced into a prominent median ridge. Muscular area quadruplicate. Shell-structure very compact and finely fibrous, without punctation.

(Lower — Upper Silurian.)

Heterorthis, Hall. 1892.

VIII. Group of ORTHIS CLYTIE, Hall.

(Plate 11, Figs. 1–3.)

Contour leptænoid. Shell transversely oval, with a straight hinge-line and rounded cardinal extremities; its form is depressed plano-convex, the convexity of the pedicle-valve being slight.

The cardinal area is about equally developed on each valve. Surface ornamented by fine, rounded, radiating striæ between each two of which are from two to six much finer radiating lines; all these are crenulated by exceedingly faint growth-lines.

The interior of the pedicle-valve has short teeth with prominent extremities, and inconspicuous dental lamellæ. The muscular impression is large and consists of a small adductor scar situated centrally, and two lateral scars which are flabellate and greatly elongated, but not uniting in front and inclosing the adductor, as is usual in typical forms of ORTHIS. These lateral scars are divided into subordinate impressions, of which the outer posterior members may represent the adjustors. In the brachial valve the dental sockets are obscure, the crural plates oblique, terminating abruptly at the bases of the crura, their lower part being continued in a low ridge surrounding a short subcircular muscular area, which is very obscurely quadrilobate. The cardinal process has a vertical, sharp, simple, posterior edge, but is much thickened where it unites with the crural plates, and is produced along the muscular area as a prominent median ridge. From the antelateral margins of the muscular area radiate six low, somewhat sinuous ridges of similar character to those frequently seen in members of Group XI. Both valves are considerably thickened just within the margins, as in many strophomenoids.

The shell-structure is finely fibrous and perforated by minute punctations which are in general sparsely developed, but most distinctly arranged in radiating rows corresponding to the surface striæ.

(Lower Silurian.)

Bilobites, Linné. 1775.

Synonym: *Dicœlosia*, King. 1850.

IX. Group of ORTHIS BILOBA, Linné.

(Plate 10, Figs. 14–19.)

Shells small, strongly bilobed. Hinge-line short; teeth and sockets obscure; cardinal process small and simple. Crural plates thin and very long, often extending as far forward as the commencement of the lobation. Muscular area indistinct, larger in the brachial, than in the pedicle-valve. Shell-substance fibrous and punctated by coarse tubules apparently arranged in radiating rows.

(Lower Silurian — Lower Devonian.)

Dalmanella, Hall. 1892.

Group of ORTHIS TESTUDINARIA, Dalman.

(Plate 11, Figs. 4–17.)

Shells plano-convex or subequally biconvex. Pedicle-valve usually the deeper, often gibbous, elevated at the umbo and arched over the cardinal area. Hinge-line generally shorter than the greatest width of the shell. In many of the species there is a more or less conspicuous, undefined median fold and sinus on the pedicle and brachial valves respectively. Surface covered with fine, rounded bifurcating striæ.

In the pedicle-valve the teeth are quite prominent, thickened at their extremities and supported by lamellæ which are produced forward, circumscribing a rather short suboval or subquadrate muscular area, which is more or less distinctly defined in different species and in different conditions of the shell.

In the brachial valve the cardinal process extends forward to the bases of the crural plates, where it is broadened and continued thence as a median ridge separating the muscular impressions. The inner surface of this process is divided by a faint median furrow which produces two lobes at the posterior extremity, and each of these lobes is again divided, making the process quadrilobate. Sometimes the inner divisions of the two main lobes have coalesced, producing a strong median lobe and thus making the process appear trilobate. In some species, at maturity, and in others from abnormal growth, this process becomes a broad plug, which fills the entire delthyrial opening. The dental sockets are small, the crural plates often greatly elevated, especially in the plano-convex forms, and they are not usually produced into a ridge about the muscular area, but end abruptly. Muscular impressions quadruplicate, sometimes with radiating ridges extending from the lateral and anterior margins.

Shell-substance finely fibrous and punctate.

(Lower Silurian — Upper Silurian.)

Rhipidomella, Œhlert. 1890.

Synonym: *Rhipidomys*, Œhlert. 1887.

XI. Group of ORTHIS MICHELINI, Léveillé.

(Plate 12, Figs. 1–13.)

Shell subcircular in outline, biconvex and sublenticular, with the brachial valve somewhat the deeper Hinge-line short, cardinal area narrow, especially on the brachial valve. The surface bears a slight median depression on each valve, and is covered with fine, rounded, subequal striæ which are hollow, often opening upon the surface; these openings probably represent the broken bases of short tubular spines.

The pedicle-valve bears two strong diverging teeth, planted firmly upon the valve at the bottom of the delthyrium, and extending upward and outward at their extremities; from their bases a more or less strongly defined curving ridge extends forward, bordering the muscular area. The muscular area extends from one-third to five-sixths the length of the valve and is deeply impressed; the pedicle-scar fills the entire rostral cavity; the adductors occupy a small central scar which is completely enveloped by the great diductors. A median ridge arises in front of the adductors, dividing the diductors; sometimes the latter scars rest upon a general anterior flattening of this ridge, and in rare instances the ridge divides the separate components of the adductor impression. The margin of the entire muscular area is thickened and elevated, and outside of this are deeply pitted ovarian markings.

In the brachial valve the dental sockets are deep and narrow, the crural plates extremely prominent, sometimes supporting short crura. The cardinal process is erect, strongly arched on its anterior face, often very thick and greatly elevated; the edge of its posterior face is multilobate, the posterior surface itself having a trilobed appearance The muscular area is quadruplicate, comparatively small and usually indistinct. A broad, low, median ridge extends forward from the base of the cardinal process. The shell-structure is coarsely fibrous and very strongly punctate, the perforations being large and generally more abundant along the furrows between the striæ.

(Upper Silurian — Upper Carboniferous.)

Schizophoria, King. 1850.

XII. Group of ORTHIS RESUPINATA. Martin.

(Plate 11, Figs. 18–23.)

Shells resupinate or with normal convexity reversed as in Groups IV, V, VI. Surface very finely striate, the striæ being hollow, tubulose and produced into short spines as in RHIPIDOMELLA. In the pedicle-valve there is a short subquadrate or obcordate muscular area with thickened, elevated margins, and deeply sunk in the substance of the shell; in the opposite valve a less distinctly defined, quadripartite area. In the brachial valve the crural plates are erect and divergent; the cardinal process, which in young shells, has much the same character as in RHIPIDOMELLA, becomes resorbed and thus narrowed with age, making a thin and sharp ridge; concomitant with this change is the formation, in the delthyrial cavity, of one, two or even three minor ridges on each side of the original process, so that in old shells the posterior face of the process appears to be multilobate. In this valve four (rarely six) deep pallial sinuses take their origin at the anterior margin of the muscular area, passing forward as broad, simple, subparallel bands, to near the margin of the valve, where they bifurcate and become arborescent. Shell substance highly punctate.

(Upper Silurian—Coal Measures.)

Orthotichia, Hall. 1892.

XIII. Group of ORTHIS ? MORGANIANA, Derby.

(Plate 12, Figs. 14–17.)

External form as in SCHIZOPHORIA. In the pedicle-valve the dental lamellæ are highly developed, between them lying a conspicuous median septum; muscular area not deeply impressed. Shell substance punctate.

(Carboniferous; Brazil, India.)

Enteletes, Fischer de Waldheim. 1830.

XIV. Group of *Enteletes Lamarcki*, Fischer de Waldheim.

(Plate 12, Figs. 18–21.)

Valves strongly inflated; brachial valve the more convex. Surface coarsely ribbed and covered with fine radial striæ. Hinge-line short; cardinal area of pedicle-valve highly developed. On the interior the pedicle-valve bears strong teeth, highly developed convergent dental lamellæ, and an elevated median septum which extends to the middle of the valve, terminating abruptly. In the brachial valve the crura are recurved over the cardinal line and are supported by strong septa; cardinal process small, erect and multilobate. Muscular scars very faint. Shell substance punctate, tubulose at the surface.

(Carboniferous.)

Billingsella, Hall. 1892.

(Plate 8, Figs. 1, 2.)

Shell transverse: subquadrate or semicircular in outline. Contour concavo—, or plano-convex. Surface sharply striate or plicate. Pedicle-valve the more convex: cardinal area moderately high, vertical or slightly incurved. Delthyrium covered by a convex plate, which, in rare instances, may be minutely perforated at the apex; the teeth are well developed, but the dental plates are continued along the bottom of the umbonal cavity, only near the apex inclosing a small subelliptical muscular area. In the brachial valve the cardinal area is greatly inclined, making an obtuse angle with that of the opposite valve. The delthyrium is partially covered by a convex deltidium which never attains the development seen in the opposite valve, and is often wholly absent.

Type, *Orthis Pepina*, Hall.

Distribution. Cambrian—(?) Upper Silurian.

Protorthis, Hall. 1892.

(Plate 8, Figs 3–7.)

Shells small, transversely subquadrate or semicircular. Hinge-line straight, its length being equal to the greatest width of the valves. Valves unequally biconvex, or sub-planoconvex, the pedicle-valve being the larger. The cardinal area is narrow on both valves, but is higher on the pedicle-valve, and is transected by a broad delthyrium which is closed below by a concave plate apparently produced by the union of the dental lamellæ, which are not continued to the bottom of the valve; teeth distinctly developed. In the brachial valve the cardinal area also bears an open delthyrium; the dental sockets are obscure and the crural plates small; the latter appear to unite and form a low elevation across the base of the delthyrium. Cardinal process absent or rudimentary in all the specimens examined. Muscular markings in both valves extremely obscure.

Surface marked by distinct plications, with interstitial finer radii, which are crossed by delicate concentric striæ; these are usually accompanied by a low sinus and fold on the brachial and pedicle-valves, respectively; interior very finely papillose. Shell-substance fibrous and apparently punctate.

Type, *Orthis Billingsi*, Hartt. (Cambrian.)

Clitambonites, Pander. 1830.

(Plate 8, Figs. 8, 9.)

Synonyms; *Pronites*, *Gonambonites*, Pander. 1830.

Shells with a subsemicircular marginal outline; convex or subpyramidal in the typical group. Hinge-line straight and forming the greatest diameter of the shell. Pedicle-valve elevated, cardinal area high, vertical, or sometimes incurved, and crossed by a broad delthyrium, which is normally covered by a convex, perforate deltidium. On the interior of the valve the dental lamellæ are very strongly developed, converging and uniting in the median line before reaching the bottom of the valve: thus forming a spondylium, which, with the deltidium, incloses a conical subrostral vault. This plate is supported by a median septum extending for about one-half the length of the valve. Muscular impressions obscure. In the brachial valve the cardinal area is considerably developed, and the delthyrium filled by a conspicuous callosity, against the inner side of which the simple orthoid cardinal process abuts. The dental sockets are large, the crural plates low and continuous with the edges of the delthyrial callosity. A thickened transverse area is formed in the umbonal region by the union of the inner portions of the crural plates with the cardinal process, and thence a broad median ridge is continued forward through the muscular area, which is sharply defined and quadripartite. External surface covered with radiating striæ. Shell-substance impunctate.

Type, *Clitambonites adscendens*, Pander.

Distribution. Lower Silurian.

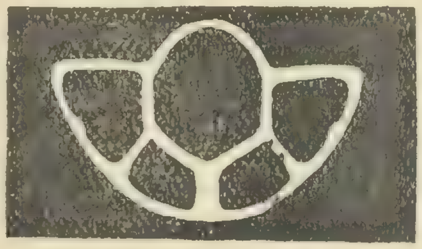
HEMIPRONITES, Pander, 1830. (Plate 8, Figs. 14, 15.) Shells as in CLITAMBONITES but with shorter hinge-line and subequally convex valves. Type, *H. tumida*, Pander; Lower Silurian).

ORTHISINA D'Orbigny, 1847. (Plate 8, Figs 10–13.) Shells as in CLITAMBONITES but with the cardinal area and chilidium of the brachial valve extravagantly developed. Type, *O. anomala*, Schlotheim (sp.) Lower Silurian).

Subgenus **Polytœchia**, Hall. 1892.

(Plate 8, Figs. 16–20.)

Shell small, subtrihedral in contour. Hinge-line straight, about equaling the diameter of the shell. Pedicle-valve with a high, nearly vertical cardinal area marked with oblique striations parallel to the lateral margins. Delthyrium covered by a narrow, convex plate; the presence of a foramen not determined. On the interior the dental lamellæ are widely separated, and descend along the umbonal cavity for a short distance vertically, thence bending sharply inward and meeting at a low angle in the median line; thus forming, with the deltidium, a conspicuous subrostral vault. This is supported by a stout median septum, and two smaller lateral septa, which meet it at the lines of angulation; the former of these extends for the entire length of the plate, while the latter is free from the accessory septa near its anterior edge. The umbonal cavity of the valve is thus divided into five chambers, and in the lateral chambers there is still another septum, lower than the rest and not extending to the spondylium. The brachial valve is shallow and depressed-convex, with a narrow cardinal area. The delthyrium is very broad with a partially developed covering, the dental sockets are widely separated, the crural plates narrow and nearly parallel to to the hinge-line. The cardinal process is simple, linear and quite prominent, and at its union with the crural plates is a subtriangular thickening which is supported by a low median septum. Surface covered with fine, elevated, radiating striæ, without evidence of median fold and sinus.



Polytœchia apicalis.
FIG. 269.—Transverse section of pedicle-valve, near the apex.

Type, *Hemipronites apicalis*, Whitfield.
(Lower Silurian.)

Scenidium, Hall. 1860.

(Plate 8, Figs. 21–27.)

Synonym; *Mystrophora*, Kayser, 1871.

Shell subpyramidal, somewhat semicircular, with or without median sinus and elevation. Pedicle-valve elevated, subpyramidal; beak straight or slightly arched; muscular impressions undetermined. Cardinal area large, triangular, divided by a narrow fissure, which is sometimes closed at the summit by a concave plate. Brachial valve flat, or varying from depressed-convex to concave. Beak entire, or indented by the foramen; cardinal line straight and usually equaling the width of the shell; crural plates broad and well developed, marked by the imprints of the pedicle muscles, and produced in the middle in a pointed process: the cardinal process extends, as a median septum, through the length of the shell, and may be simple or divided at its anterior extremity. Exterior surface covered with radiating striæ.

Type, *Scenidium insigne*, Hall.

Distribution. Lower Silurian — Middle Devonian.

Orthidium, Hall. 1892.

(Plate 8, Figs. 28–31.)

Shell very small, transverse, having the external aspect of SCENIDIUM. Hinge-line long, making the greatest diameter of the shell. Pedicle-valve the more convex; cardinal area moderately high, with a broad open delthyrium, strong teeth and inconspicuous dental plates: in all respects like the corresponding valve of *Orthis calligramma.* Brachial valve slightly convex; cardinal area very narrow; dental sockets well developed, crural plates very short and erect, coalesced with the cardinal process, which thus becomes a vertical, transverse, subcrescentic plate, at the base of which the shell is somewhat excavated; muscular scar quadruplicate. Surface covered with radiating striæ, which extend over the broad, low sinus and fold in the brachial and pedicle-valves respectively. In the former the sinus makes a prominent median ridge in the interior of the valve. Shell-structure not determined.

Type, *Orthidium gemmicula*, Billings.

(Lower Silurian.)

Leptella, Hall. 1892.

(Plate 13, Figs. 10–12.)

Shells small, normally concavo-convex. Outline semicircular or semielliptical. Hinge-line straight, making the greatest diameter of the shell. Pedicle-valve evenly convex, cardinal area moderately high, delthyrium for most of its extent covered by a convex plate; teeth inconspicuous and unsupported by lamellæ; muscular impressions undetermined. Brachial valve slightly concave; cardinal area comparatively high; the delthyrium filled by the cardinal process, which, as viewed from behind, is divided by a median groove for its entire height. On the cardinal margin this process is double but less conspicuous than the crural plates, which are arched and highly elevated above the hinge-line. They are short, terminate abruptly, and inclose deep sockets. The visceral area is flattened or concave, its anterior margin forming a double curve, from which line the surface of the valve is abruptly deflected. This visceral area is divided by a broad median ridge and its surface covered with fine, sharp radiating lines which end at the line of deflection.

Type, *Leptella sordida*, Billings.

Distribution. Cambrian — Lower Silurian.

Leptæna, Dalman. 1828.

(Plate 13, Figs. 1–4, 6–9.)

Synonym; *Leptagonia*, McCoy, 1844.

Shells plano-convex when young, concavo-convex at maturity; convexity normal. Surface covered by conspicuous concentric corrugations or wrinkles over the flatter portions of the valves. Where these cease the surface is more or less abruptly and often rectangularly deflected, forming a conspicuous anterior slope. The whole exterior is covered with fine, even, radiating, thread-like, tubular striæ, which, in well-preserved specimens, are crenulated by finer concentric striæ. Outline transversely subquadrate or semioval. Hinge-line straight, its length making the greatest diameter of the shell; extremities often subauriculate. Cardinal area narrow, slightly wider on the pedicle-valve, not denticulate. In the pedicle-valve, the delthyrium is covered by a convex deltidium, perforated at the apex by a foramen which is closed at maturity or encroaches upon the apex of the valve.

This deltidium is most conspicuously developed in early stages of growth, when it has the form of a tube or sheath, which character becomes obliterated as maturity approaches, by the increase in the size of the cardinal process, and the deltidial callosity formed about its base: In adult shells the foramen has become inclosed by the substance of the shell, its external opening being an oblique groove in front of the apex of the valve, and its inner aperture appearing in front of the pedicle-scar. Not infrequently the passage is closed at maturity. The teeth are very divergent and quite conspicuous, generally supported by lamellæ which are continued around the subcircular muscular area of the narrow umbonal cavity. The muscular scars consist of a narrow median or adductor, inclosed by flabelliform diductors.

In the brachial valve the area is linear, the delthyrium is progressively filled by the growth of a callosity, which is often deeply grooved, along the center, and sometimes perforated in the line of division between the branches of the cardinal process. The cardinal process consists of two sessile, diverging apophyses which have broad, flat, striated surfaces of attachment, and are extended beyond the hinge-line. The sockets are moderately deep; the crural plates are usually not sharply defined, but are continued in a curving line along the inner surface of the valve, partially embracing a pair of broad, ovate muscular impressions which are marked by aborescent ramifications; recurving and again incurving, these ridges partially surround a pair of smaller muscular areas, lying in front of the first. At the inner base of each branch of the cardinal process there arises a low elevation or callosity, which, extending obliquely forward, and uniting in the center, continues as a narrow median ridge dividing the posterior pair of muscular impressions. This ridge sometimes terminates in a point near the base of the first pair of impressions, and the second pair are separated by a low, slender median septum, which sometimes apparently takes its origin at this point, but which is in fact a continuation from the interrupted posterior ridge, and extends for some distance over the pallial region.

The muscular area, when its features are most distinctly retained, shows the subdivision into the following scars: (*a*) A large posterior pair (the posterior adductors), the surface of which is covered with arborescent ridges; the anterior portion of each of these scars is smoother than the rest, generally much thickened and often extremely elevated at its outer margins. These may be regarded as accessory elements of the posterior adductors. (*b*) An anterior pair (anterior adductors), situated close together at about the center of the valve. The position of these is generally well defined but their outline is frequently obscure. (*c*) An elongate, narrow median scar, which is apparently divided for its entire length by a faint ridge. In front of the muscular area there are often a number of short protuberances on each side of the median septum, and the anterior pair of scars is frequently obliterated by prominent callosities. At the line of geniculation the interior surface is elevated into a very prominent, sharp, or abruptly rounded crest. Spiral callosities for the support of the brachia, similar to those in DAVIDSONIA and LEPTÆNISCA, have been observed.

Shell-substance strongly punctate.

Type, *Leptæna rugosa*, Dalman.

Distribution. Silurian — Carboniferous.

Rafinesquina, Hall. 1892.

(Plate 13, Figs. 513-18.)

Shells normally concavo-convex. Surface ornamented by radiating striæ, of alternating size, crossed and crenulated by finer concentric striæ. Cardinal margins without denticulations. Interior of the pedicle-valve with the muscular area not strongly limited: consisting of two broad flabellate diductor scars inclosing an elongate, more distinctly defined adductor. The faintness of the limitation of this area is in marked contrast to the sharply defined muscular area in the corresponding valve of LEPTÆNA. In the brachial valve the cardinal process is more closely sessile than in LEPTÆNA, and there is frequently a linear callosity between the branches. The posterior adductor scars have the arborescent markings of *Leptæna rhomboidalis*, and these impressions are the only ones well defined, the anterior scars being narrow and rarely retained with distinctness. From the anterior margin of the muscular area radiates a series of irregular furrows and nodose ridges, which are to some extent of vascular origin.

Type, *Rafinesquina alternata*, Conrad (sp.).

Distribution. Lower — (?) Upper Silurian.

Stropheodonta, Hall. 1852.

(Plate 14, Figs. 1-6.)

Shells normally concavo-convex. Cardinal area common to the two valves, that of the brachial valve narrower or linear; smooth or finely striated longitudinally, sometimes showing through the outer laminæ of the shell, strong, parallel, transverse bars, which project beyond the cardinal margin as short processes, and articulate with a corresponding series of pits in the opposite valve. The earliest species have these denticulations developed only for a short distance on each side of the center, while in the latter faunas they extend the entire length of the hinge-line. In the type-species the delthyrium is usually completely closed by the extension of the shelly laminæ of the area, and on the inside by the formation of a callosity between the apophyses of the cardinal process. Sometimes a low, narrow, convex deltidium is present, and in the early species the delthyrium is frequently open.

From the normal position of the dental lamellæ there extend two diverging, sometimes nearly vertical ridges of variable strength bounding the post-lateral portion of the muscular area, which is not limited by a ridge in front. The entire muscular area consists of two broad flabelliform diductor scars, inclosing an oval adductor which is distinctly divided into anterior and posterior elements. The foramen, dental plates and teeth are obsolete or obsolescent in the Devonian species.

In the brachial valve the delthyrium is also usually closed, the cardinal apophyses are strongly arched into the umbonal cavity of the opposite valve, their surfaces of attachment being sometimes nearly parallel to the plane of the cardinal area of the brachial valve, and often extending beyond it. Small crural plates are always present, though they could not have been functional at maturity. Muscular arrangement similar to that of *Rafinesquina alternata*, the posterior scars being more elongate the anterior pair usually less defined, and all the scars frequently obscured. The anterior muscular fulcra are sometimes developed into very prominent elongate apophyses. The median septum often becomes elevated into a high crest at the center of the valve. Over the pallial region the interior of both valves is strongly papillose. External surface covered with radiating, sometimes fasciculate striæ; rarely smooth. Shell-substance fibrous, coarsely punctate.

Type, *Stropheodonta demissa*, Conrad (sp.).

Distribution. Lower Silurian (?) — Upper Devonian.

Subgenus **Pholidostrophia**, Hall. 1892.

(Plate 14, Figs. 11–15.)

Shells small; surface smooth or squamous; nacreous. Interior of the brachial valve with three diverging ridges in front of the muscular area. (Type, *P. nacrea*, Hall (sp.). Devonian.)

Subgenus **Leptostrophia**, Hall. 1892.

(Plate 15, Figs. 1–4.)

Shell plano-convex or flat; delthyrium more or less completely closed. In the pedicle-valve are two pustulose diverging ridges, bounding the sides of the muscular area. Cardinal scars broad and flabellate; not distinctly limited anteriorly. (Type, *L. magnifica*, Hall. Devonian.)

(?) Subgenus **Brachyprion**, Shaler. 1865.

(Plate 14, Figs. 7–10.)

Shells with delthyrium open or partially covered; crenulations of the cardinal margin confined to a very limited extent on either side of the fissure.

(Type, *B. Leda*, Billings (sp.). Upper Silurian.)

Subgenus **Douvillina**, Œhlert. 1887.

(Plate 14, Figs. 16–19.)

Shells having a crenulated hinge and flat deltidium. In the pedicle-valve are two small teeth connected with diverging ridges which are strongly elevated in front, and inclose a transverse muscular area. Beneath the beak are two crests supported by a short median septum; posteriorly these all unite to form a single apophysis grooved in the middle and uniting with the inner surface of the deltidium. The brachial valve has a prominent bifid cardinal process, and a pair of small protuberances representing the crural plates; from the base of the cardinal process extends a median

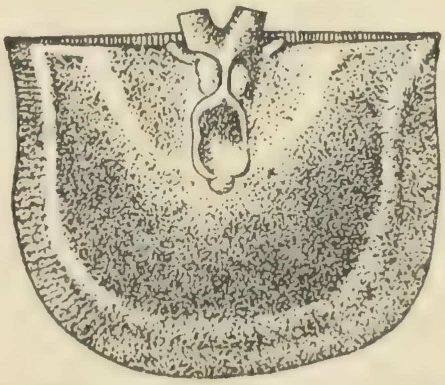
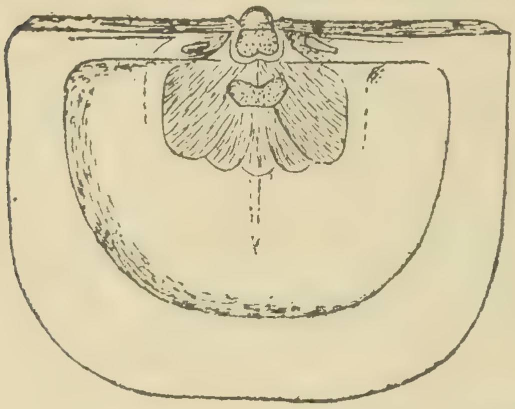


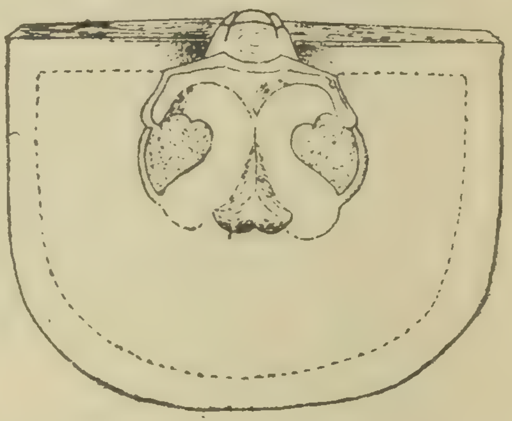
FIG. 270.— Brachial valve of *Douvillina Dutertrii*. After ŒHLERT.

ridge which bifurcates anteriorly inclosing a cavity for the insertion of the anterior adductors. (Type, *D. Dutertrii*, Murchison (sp.). Devonian.)

Cadomella, Munier-Chalmas. 1887.

Shell nearly flat or gently concavo-convex; hinge-line long, straight; beak of pedicle-valve scarcely prominent; cardinal areas linear; deltidium narrow. On the interior the pedicle-valve bears divergent teeth between which lies an apophysis, serving as a base of attachment for the accessory diductors. The principal diductor scars are flabellate, but do not extend beyond the umbonal region. In the brachial valve is a stout cardinal process, grooved upon its upper surface near the lateral margins. Socket-walls greatly elevated and continued into curved crural apophyses which have a tendency to become free toward their extremities. There is a median septum which, at its anterior end, at the center of the valve, is strongly elevated and bilobed. The four adductor impressions united into two cordate scars whose outer margins are strongly thickened.





Cadomella Moorii.

FIG. 271.—Interior of pedicle-valve. FIG. 272.—Interior of brachial valve. (MUNIER-CHALMAS.)

Type, *Cadomella Moorii*, Davidson (Lias).

Strophonella, Hall. 1879.

(Plate 15, Figs. 5–11.)

Shells semicircular or semielliptical, concavo-convex, resupinate, the pedicle-valve concave and the brachial valve convex. Area of pedicle-valve striated, solid, with or without a central deltidial scar, or rarely a partial foramen, with similar features on the narrow area of the brachial valve; inner margins of the cardinal areas of each valve crenulate, and from beneath the center of the ventral area there is often a strong process (frequently bilobed) which extends beyond the cardinal line. Muscular area of the pedicle-valve strongly marked, and limited by a prominent border. Brachial valve with a narrow hinge-area transversely or longitudinally striate, or both, and marked in the center by a deltidial scar. Cardinal process double, each division notched or bidentate at the extremity; muscular areas quadrangular.

Type, *Strophonella fasciata*, Hall.

Distribution. Upper Silurian — Upper Devonian.

Subgenus **Amphistrophia**, Hall. 1892.

(Plate 15, Figs. 12–14.)

Shells with convex deltidium and very short row of cardinal denticulations. In the pedicle-valve the muscular area is not inclosed; in the brachial valve muscular markings extremely faint.

(Type, *A. striata*, Hall (sp.). Upper Silurian.)

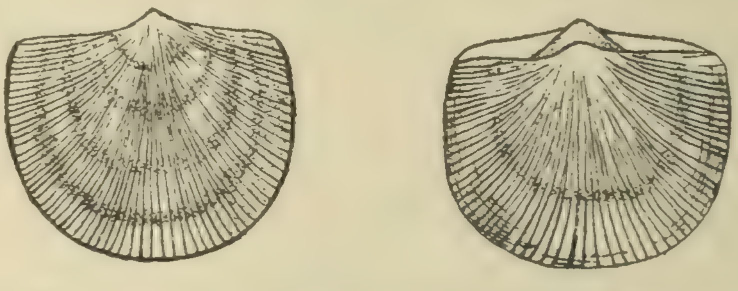
Strophomena, Rafinesque (de Blainville). 1825.

(Plate 14, Figs. 1–7.)

Synonyms: (?) *Strophomenes*, Rafinesque, 1820, 1831; Defrance, 1824.

Shells transversely subsemicircular or semielliptical; greatest width along the hinge-line. Surface concavo-convex and covered with fine radiating striæ which are equal or alternate in size. The pedicle-valve is slightly convex about the umbo, but becomes rapidly concave toward the middle with the apex perforated, except in old age. The cardinal area is conspicuous and nearly vertical, and the delthyrium closed by a convex plate or deltidium. Teeth widely divergent and supported by plates which are produced into elevated ridges nearly surrounding the muscular area. The latter is relatively short, subcircular in outline, deeply excavated and divided medially by a more or less distinctly defined longitudinal ridge which is often continued over the pallial region.

The brachial valve is concave at the umbo, becoming strongly convex with growth; it has much the narrower cardinal area, and the delthyrium is rudimentary or incomplete. Dental sockets deep, and continued as narrow grooves or indentations across the cardinal area. The crural plates are extended laterally with a slight curve, but are not supported by septa; at their inner margins they unite to form a callosity, upon which rests the short, bilobed cardinal process, which scarcely extends beyond the hinge-line. The muscular surface of this process is cordate in outline and is placed at a low angle to the plane of the area. A low median ridge extends forward from the hinge-plate separating two large adductor scars, in front of which are two narrow elongate impressions. Vascular and ovarian markings frequently well defined. Shell-substance fibrous, strongly punctate.



FIGS. 273, 274.—*Strophomena rugosa*. After DE BLAINVILLE.

Type. *Strophomena rugosa* Rafinesque (de Blainville), 1825,= *Leptæna planumbona*, Hall, 1847, as recognized by KING and other authors.

Distribution, Lower —(?) Upper Silurian.

Orthothetes, Fischer de Waldheim. 1830.

(Plate 14, Figs. 8–16.)

Shells plano-convex or biconvex, sometimes becoming concavo-convex with age. Brachial valve usually the deeper in the pallial region; pedicle-valve highest about the umbo, which is sometimes much extended, and often shows a pronounced tendency to irregular growth. Surface covered with slender, subequal radii, which are crenulated by sharp concentric striæ. Hinge-line long, equaling, and often greater than the width of the shell; in some species frequently showing a tendency to auriculation at the extremities. Pedicle-valve with the cardinal area prominently developed; the delthyrium covered by a thick, more or less convex deltidium, which is rarely if ever perforated at maturity. On the interior the teeth are moderately large, sometimes thickened, but not supported by dental plates. The muscular area is marked by flabelliform cardinal scars, inclosing a small adductor impression.

In the brachial valve the cardinal area is narrow, the deltidial covering small and emarginate at the center. The cardinal process is united to the crural plates, the whole forming a vertical subcrescentic process, most elevated centrally and notched or divided at its crest, making it bilobed or bidentate, as seen from its inner surface ; on its outer or posterior face each apophysis is deeply grooved, giving the entire cardinal process, from this point of view, a distinctly quadrilobate appearance. The crural plates end more or less abruptly in elevated points, which undoubtedly mark the place of attachment of the crura. The bases of these plates are not produced around the muscular area. Muscular impression flabelliform, very much as in the other valve; divided medially by a low faint ridge. Shell-substance strongly punctate.

Type, *Orthothetes crenistria*, Phillips (sp.).

Distribution. Upper Silurian — Carboniferous.

Hipparionyx, Vanuxem. 1842.

(Plate 14, Figs. 17–20.)

Shell large, subhemispherical. In youth, the pedicle-valve is very slightly convex, but at maturity it is depressed, or concave, over the pallial region. The brachial valve is always very convex. Marginal outline of the valve subcircular. On the pedicle-valve the hinge-line is straight but short, the cardinal area low, and the beak retrorse. The delthyrium is broad, and covered by an imperforate convex deltidium. The teeth are moderately large and are supported by lamellæ which extend to the bottom of the umbonal cavity, and are produced into strong ridges entirely surrounding the muscular area. This area is very large and is composed of broad, flabellate diductors inclosing an elongate or cordate adductor impression. There is a low median septum in the umbonal cavity, separating the arms of the cardinal process of the opposite valve, but it is quite short, disappearing at the adductor scar, though sometimes reappearing in front of it.

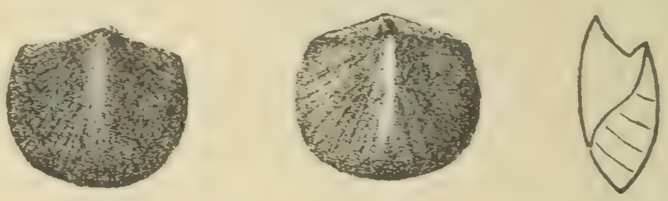
In the brachial valve there is no cardinal area. The cardinal process has essentially the same structure as in ORTHOTHETES and DERBYA, but is very high, its two branches completely traversing the umbonal cavity of the opposite valve; it is supported by a short, median septum, and laterally by strong crural plates which extend for a short distance along the margins of the muscular impressions; these are usually quite faint and undefined, occupying a much smaller area than in the pedicle-valve, and leaving arborescent markings as in some species of STROPHEODONTA. On the interior of both valves the margin is sharply pectinated, or crenulated, the crenulations on the brachial valve extending to the base of the cardinal process, and in the pedicle-valve extending for a considerable distance on the cardinal area. Surface of both valves covered with fine sharp radiating striæ. Shell substance punctate.

Type, *Hipparionyx proximus*, Vanuxem.

Distribution. Lower Devonian (Oriskany sandstone; but a single species is known).

Kayserella, Hall. 1892.

Shell subsemicircular; hinge-line nearly equaling in length the greatest width of the shell; convexity normal. Pedicle-valve more convex than the brachial; area moderately high; delthyrium covered by a convex plate. Brachial valve slightly convex; area narrow; chilidium well developed. In the interior, a large triangular median septum extends almost to the bottom of the opposite valve. Surface with a slight median ridge and furrow on pedicle and brachial valves respectively; covered with sharp plications, increasing by intercalation near the margin. Shell substance punctate.



FIGS. 275, 276, 277.— *Kayserella lepida*. After KAYSER.

Type, *Kayserella lepida*, Schnur (sp.).

Distribution. Middle Devonian (Eifel; but a single species is known).

Derbya, Waagen. 1884.

(Plate 17, Figs. 1–9.)

General character of the shell as in ORTHOTHETES. The external form is more variable, being usually plano-convex, sometimes concavo-convex, the pedicle-valve often the more elevated and subpyramidal, becoming irregular in its growth toward the apex. The interior of the pedicle-valve bears a high median septum, extending longitudinally through the center of the muscular area, which is from one-third to two-thirds the length of the valve; near the apex of the umbonal cavity it unites with the dental plates forming a small triangular chamber beneath the deltidumi. In old shells this cavity is often filled by testaceous secretion. The dental plates do not extend to the bottom of the rostral cavity except near the apex.

Brachial valve broad and regularly convex, or sometimes with an undefined median depression, and showing a tendency to auriculation at the cardinal extremities. Cardinal area linear; the crural plates are abruptly elevated, and unite to form a strong, erect cardinal process, which is distinctly bilobed at the summit; each lobe being slightly notched at the summit and distinctly grooved along the posterior face, these grooves uniting in a wider one at the posterior base of the process. Midway in their length these crural plates are marked by a transverse ridge which terminates on their anterior face in points for the attachment of the crura; on the inside of the dental sockets there is a distinct, sometimes strongly defined ridge, extending along the lateral margin of the broad flabelliform muscular area, and gradually becoming obsolete. There is also a slight median ridge which becomes obsolete below the middle of the muscular area. Surface marked by strong, sharply elevated radii, which alternate with finer ones, all being crenulated, and the intermediate space cancellated by fine concentric striæ.

Type, *Derbya regularis*, Waagen.

Distribution. Carboniferous.

Meekella, White and St. John. 1868.

(Plate 17, Figs. 10–13.)

Shell robust, biconvex, often subpyramidal. Hinge-line straight and shorter than the greatest width of the shell. On the pedicle-valve the cardinal area is often greatly elevated and distorted; the delthyrium is covered; the convex portion of the deltidium being much narrower than the space between the dental ridges. In the interior the teeth are prominent and supported by septiform dental lamellæ which reach the bottom of the umbonal cavity and extend forward for one-third or one-half the length of the shell. The brachial valve has a full, gibbous umbo, and a rudimentary or linear cardinal area. On the interior are two divergent lamellæ or crural plates, which are extended forward for more than one-third the length of the valve, supporting a high, erect cardinal process, which sometimes reaches almost to the apex of the umbonal cavity in the opposite valve. This process is a somewhat curved, thin, crescentic plate, bearing on its summit two slender median apophyses, below which are two stouter lateral projections having the form of extended, rounded lobes, which form the bases of the crura. Surface of the valves marked with coarse costæ, which, with the interspaces, are covered by fine radiating, often plumose, striæ. Shell-substance fibrous, punctate.

Type, *Meekella striatocostata*, Cox (sp.).

Distribution. Upper Carboniferous.

Streptorhynchus, King. 1850.

(Plate 17, Figs. 14–18.)

Shells somewhat trihedral and subpyramidal, with base convex; hinge-line shorter than the greatest width of the valves. Pedicle valve having the beak acute and often incurved and distorted. Cardinal area high, somewhat incurved; delthyrium covered by a broad imperforate, depressed-convex deltidium. The interior of the valve with low dental ridges terminating in teeth of moderate size; these ridges are not septiform and do not continue to the bottom of the umbonal cavity; there is no median septum; muscular scars strong and flabelliform.

In the brachial valve the cardinal area is linear, the crural plates are vertical and abruptly elevated on their anterior edges, forming points of attachment for the crura; these unite to form a subcrescentic plate, from the center of which arises a broad, erect, cardinal process, which is deeply divided into two lobes, each of which is faintly grooved at its summit and on the posterior face; muscular area small, divided medially by a low ridge. Exterior surface covered by fine radiating striæ.

Type, *Streptorhynchus pelargonatus*, Schlotheim (sp.).

Distribution. Carboniferous (?) — Permian.

Triplecia, Hall. 1858.

(Plate 18, Figs. 1–15.)

Synonym; *Dicraniscus, Meek*, 1872.

Shell trilobate, transverse, unequally biconvex. Hinge-line straight and quite short. Pedicle-valve shallow, convex about the beak, but depressed anteriorly by a broad and deep median sinus; cardinal area low, erect and well defined; delthyrium covered by a narrow, convex plate, with a circular foramen at the apex. In the interior the teeth are well developed and supported by short dental lamellæ longitudinally dividing the umbonal cavity near its apex. Muscular area small, comprising two lateral scars, separated by a longer central adductor impression. The brachial-valve is very convex, and bears a strong median fold. The cardinal area is very narrow and the beak closely incurved. In the interior is a long, erect and bifurcate cardinal process, the distal extremity of each branch bearing a single deep groove. This process is supported on a subrostral callosity, which also bears two short spiniform crural points at its base. Shell-substance fibrous, impunctate (?). Surface with obscure concentric growth-lines, and fine radiating striæ on the inner laminæ; in rare instances there are radiating lines on the exterior.

Type, *Triplecia extans*, Emmons, (sp.)

Distribution. Lower — upper Silurian.

Mimulus, Barrande. 1879.

(Plate 18, Figs. 16–19.)

Contour trilobate as in TRIPLECIA median fold on the pedicle-valve in the typical species. Shells sometimes bilaterally unsymmetrical. Cardinal area of the pedicle-valve smooth, with but little if any external evidence of deltidium. Teeth small, not supported by dental lamellæ. Brachial valve with an erect, deeply bifurcated cardinal process

Type, *Mimulus perversus*, Barrande.

Distribution. Upper Silurian.

Streptis, Davidson. 1881.

(Plate 18, Figs. 20–22.)

Shells biconvex, bilaterally unsymmetrical; divided medially by a sinus. Pedicle-valve with a well-defined cardinal area and foramen. Teeth small, supported by short dental plates. Brachial valve with an erect, probably bifurcated cardinal process. External surface covered with lamellar expansions at the concentric growth-lines.

Type, *Streptis Grayi*, Davidson.

Distribution. Upper Silurian (England and Bohemia).

Plectambonites, Pander. 1830.

(Plate 19, Figs. 1–7.)

Shells usually small, normally concavo-convex. Surface covered with very fine striæ, often alternating in size. Hinge-line making the greatest width of the shell, the extremities often subauriculate. Cardinal area narrow in both valves, sometimes obscurely crenulated on the margins. Pedicle-valve with a moderately broad delthyrium which is partially closed by a convex plate, but mostly occupied by the cardinal process of the opposite valve. Apical foramen sometimes retained. Teeth prominent and supported by thickened plates, which are continued in broad outward curves for more than half the length of the valve, returning and uniting in the unbonal cavity, thus limiting two linguiform muscular scars, inclosing a more or less clearly defined adductor impression.

In the brachial valve, the dental sockets are deep, and often appear to transect the cardinal area. The cardinal process is simple and erect, but by its coalescence with the short prominent crural plates, the posterior face appears trilobate. The crural plates end abrutly as in ORTHOTHETES; becoming thickened at about the middle of their length, giving origin to two low ridges or septa, which at first approach each other, and thence continue forward with a slight divergence, thus forming the inner boundaries of two elongate muscular scars, which are less sharply defined on their outer margins. The muscular area is rendered quadripartite by two short transverse or oblique posterior furrows. Vascular impressions radial, sometimes digitate. Shell-substance fibrous, sparsely punctate.

Type, *Plectambonites planissima*, Pander.

Distribution. Lower — Upper Silurian.

Christiania, Hall. 1892.

(Plate 19, Figs. 8–13.)

Shells usually longitudinally elongated, sometimes semielliptical in outline; normally concavo-convex. Surface smooth or covered with fine radiating lines which are crossed by stronger, rather regular concentric plications. In the pedicle-valve the cardinal area is moderately high and the delthyrium in its normal condition probably closed by a convex plate. The teeth are very divergent and from their bases extend the elevated margins of two linguiform muscular scars, traversing the shell for almost its entire length. These scars, which may be regarded as the diductors, inclose two, much shorter, but still elongate adductors. In the brachial valve the cardinal process is bipartite on its anterior face, each of the lobes being grooved behind; the crural plates are very long and divergent, terminating in elevated extremities or crura. The lower moiety of these plates is produced on each side of a strongly elevated muscular ridge, curving slightly inward on the sides, then outward on approaching the anterior margin of the valve, each branch recurving and passing backward, parallel to the median axis, as far as the base of the cardinal process. The symmetrical spaces thus limited are each divided transversely at about one-third their length from the hinge-line, by a somewhat lower vertical ridge. The four areas thus inclosed represent the posterior and anterior scars of the adductor muscles. Between the inner muscular walls, in the median line, is a low, rounded longitudinal ridge.

Type, *Christiana subquadrata*, Hall.

Distribution. Lower Silurian (?)—Devonian.

Leptænisca, Beecher. 1890.

(Plate 19, Figs. 14–21.)

Shell concavo-convex, attached to foreign objects by calcareous cementation of the pedicle-valve. Brachial valve concave; interior with a broad, more or less defined, spiral impression on each side of the median line, making a single volution. Adductor impressions small. Cardinal area narrow, bearing in the center two prominent bilobed, cardinal processes, separated to admit the vertical septum in the opposite beak. Pedicle-valve convex, area elongate triangular, fissure covered with a pedicle-sheath. Cardinal muscular scar supported on, or limited by a vertical septum, on each side of which, in the anterior half, is a small adductor scar. Shell structure punctate.

Type, *Leptænisca concava*, Hall (sp.).

Distribution. Lower Devonian.

Davidsonia, Bouchard. 1849.

(Plate 19, Figs. 22-24.)

Shell thick, plano-convex, transversely oval. Surface smooth or with concentric growth-lines, fixed to foreign bodies by the umbonal portion and the greater part of the surface of the pedicle-valve. Hinge-line straight and quite narrow. On the pedicle-valve the delthyrium is covered by a convex imperforate plate; the teeth are large, the dental lamellæ obscure. The muscular area is comparatively small, lying in the umbonal region, and is subdivided into two cardinal scars inclosing an elongate adductor. In the pallial region there is a low median septum which separates two conical callosities of the shell, having their apices directed toward the opposite valve. These protuberances are grooved by a spiral furrow which makes five or six volutions, and are frequently crossed by vascular sinuses.

In the brachial valve the chilidium is convex, embracing the base of the posterior face of the cardinal apophysis. The cardinal process has very much the same structure as in PLECTAMBONITES; consisting of a central, short, erect process, to which the crural plates are attached, giving it a trilobate appearance. These plates terminate abruptly at their distal extremities. The muscular area is quadruplicate and of about the same size as in the opposite valve. Two conical depressions in the pallial region correspond to the protuberances of the opposite valve. Shell-substance punctate (?).

Type, *Davidsonia Verneuili*, Bouchard.

Distribution. Middle Devonian (Europe).

Chonetes, Fischer de Waldheim. 1837.

(Plate 20, Figs. 1–14.)

Shells semicircular or transverse, usually normally concavo-convex, sometimes plano-convex. Hinge-line straight, making the greatest diameter of the shell. Pedicle-valve with a narrow concave or flat cardinal area; the delthyrium more or less completely covered by a convex imperforate deltidium. The upper margin of the area bears a single row of hollow vertical or divergent spines, which increase in length toward the cardinal angles; these spines are the prolongations of tubes which penetrate obliquely the substance of the shell along the cardinal line, converging toward the apex of the valve till they reach the surface, where they turn at an abrupt angle upward and outward and are thence continued as hollow spines. Cardinal teeth strong. A low median ridge, slightly thickened at its posterior extremity, where it is sometimes coalesced with the deltidium, extends forward, dividing the muscular area. The muscular scars are usually faint, and consist of flabelliform diductors which partially inclose elongate median adductors.

In the brachial valve the cardinal area is very narrow, and without spines. The deltidium is partially developed, resting against the cardinal apophysis. This process is very similar in character to that in PLECTAMBONITES, consisting of a median portion, coalescing at its base with the elongate crural plates. On its posterior face it is divided by a narrow median furrow and two broader lateral grooves, giving it a quadrilobate appearance. The crural plates are slightly divergent from the hinge-line, bounding narrow, elongate sockets. A median ridge separates the quadruplicate muscular impression and from between the anterior and posterior members of this impression originate two linear brachial ridges, which extend outward, recurving toward the median line at about the middle of the valve, making a reniform curve. Interior surface of both valves strongly papillose in the pallial region.

External surface usually covered with radiating striæ, rarely smooth or concentrically rugose. Shell-substance fibrous-punctate.

Type, *Chonetes striatella*, Dalman (sp.).

Distribution. Upper Silurian—Carboniferous.

Subgenus **Anopiia**, Hall. 1892.

(Plate 20, Figs. 15–19.)

Shells small with smooth or squamous exterior. No external evidence of cardinal spines, though the spine-tubes exist in one or more pairs in the substance of the pedicle-valve. On the interior a median septum in the pedicle-valve. Cardinal process and muscular impressions of the brachial valve as in CHONETES.

(Type, *A. nucleata*, Hall (sp.). Oriskany sandstone – Lower Devonian.)

(?) Subgenus CHONETINA, Krotow. 1888.

These shells differ from CHONETES in their very convex pedicle-valve having a profound sinus; the brachial valve, very concave, follows the curvature of the larger; in the interior of the brachial valve are tubercles arranged in radiating series which unite to form high, compact lamellæ, extending from the beak to the anterior margin; two of these, more prominent than the rest, limit the surface occupied by the sinus of the larger valve.

(Type, *C. Artiensis*, Krotow. Permian.)

Subgenus **Chonostrophia**, Hall. 1892.

(Plate 20, Figs. 20–24.)

Shell reversed concavo-convex, the pedicle-valve being slightly convex about the umbo, but becoming broadly concave over the pallial region. Outline and contour strophomenoid; valves extremely tenuous and compressed; surface covered with fine alternating or fasciculate striæ. In the pedicle-valve the upper margin of the cardinal area bears a row of hollow spines of the same structure and arrangement as in CHONETES. The delthyrium is narrow and appears to be more or less completely closed. The teeth are quite strong and rest upon the bottom of the valve; between them arises a low median septum which may be traced from one-third to one-half the length of the valve, dividing a subcordate muscular area, the outer margins of which are distinctly elevated.

In the brachial valve the crural plates are united to form a bilobed cardinal process. The outer face of this process has not been observed; on the inner surface it is not continued into a median septum but ends abruptly. Muscular area very faintly defined in the type-species. Internal surface over the pallial region finely papillose. Shell-substance fibrous, punctate.

(Type, *C. reversa*, Whitfield (sp.). Lower Devonian.)

Subgenus **Chonetella**, Waagen. 1884.

Shell small, normally concavo-convex. Surface rounded, with radial striæ; cardinal area narrow; deltidium, cardinal spines and teeth as in CHONETES. In the pedicle-valve the adductor impressions are elongate, and are partially inclosed by the larger diductors. The brachial valve has a small trilobed cardinal process, which is continued into a low medial septum. The muscular area is quadripartite and very distinct. The brachial ridges are sharply defined and appear to originate near the outer extremities of the posterior adductors, making a broad outward, and a more abrupt inward curve, completing one volution. Surface in the pallial region strongly papillose.

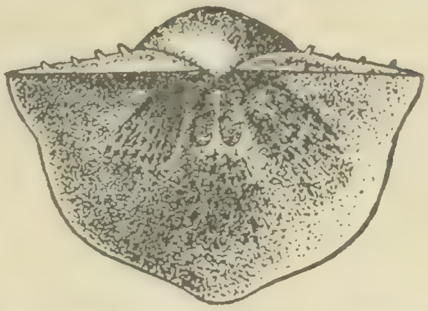


FIG. 278.—*Chonetella nasuta.* After WAAGEN.

(Type, *Chonetella nasuta*, Waagen. Upper Carboniferous.)

Chonopectus, Hall. 1892.

(Plate 20, Figs. 25–27.)

Shells normally concavo-convex; cardinal margin of pedicle-valve with a row of spines. Beak of pedicle-valve compressed or flattened from attachment in early growth. Internal markings obscure. External surface reticulated by a double, oblique series of concentric lines covering exceedingly fine radiated striæ.

Type, *Chonopectus Fischeri*, Norwood and Pratten (sp.).

Distribution. Lower Carboniferous. But a single species is known.

Strophalosia, King. 1844.

(Plate 21, Figs. 1–11.)

Shells productoid in general form; a cicatrix, usually apparent on the umbo of the pedicle-valve, indicates that they were attached to foreign bodies by the substance of the shell. Both valves have a well-defined area and covered delthyrium, these features being much the more conspicuous in the pedicle-valve. In this valve the teeth are prominent, but not supported by lamellæ; the muscular arrangement is the same as in PRODUCTUS, though the diductor impressions are relatively larger and more elongate, extending beyond the limits of the central adductors. In the brachial valve the cardinal process is erect, bifid on its anterior, and quadrifid on its posterior face. It is supported on each side by short arched crural plates, and is continued into a median septum which extends for half the length of the valve.

Muscular impressions small, quadruple, not dendritic, the interior pair being sharply raised. The brachial ridges originate from between the adductor scars, curving gently outward, recurving, at first gradually and then abruptly, to their anterior limit; thence turning suddenly backward, and again horizontally inward, meeting the median septum near its anterior extremity.

Surface of the pedicle-valve covered with spines, which near the beak are often curved backward, embracing some external object. In some species all the spines of the valve have evidently been at least of accessory importance in effecting attachment of the shell. The surface of the brachial valve may be either spinous, lamellose or smooth.

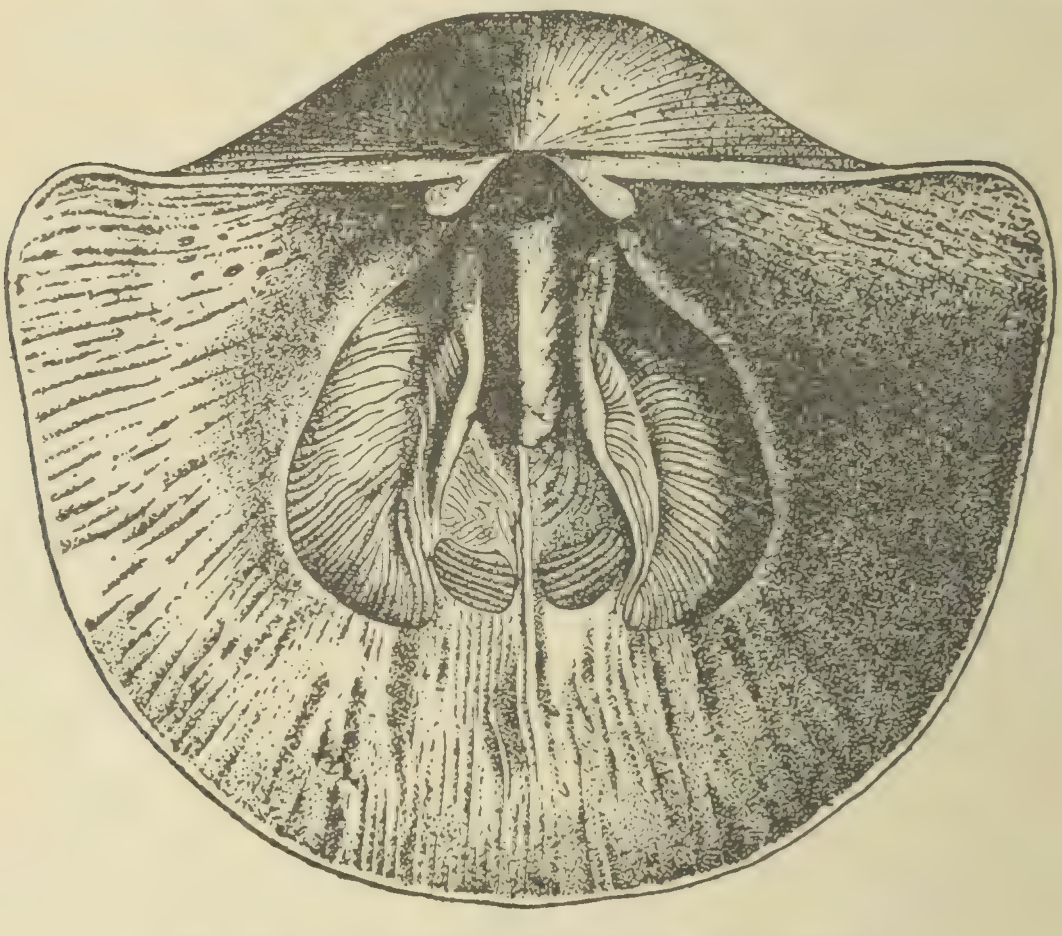


FIG. 279.—*Daviesiella Llangollensis.* (DAVIDSON.)

Type, *Strophalosia Goldfussi*, Münster.

Distribution. Middle Devonian–Permian.

Daviesiella, Waagen. 1884.

Shells large, with cardinal area and teeth well developed. External surface covered with fine radiating striæ and devoid of spines.

Type, *Daviesiella Llangollensis*, Davidson (sp).

Distribution. Coal measures.

Aulosteges, von Helmersen. 1847.

(Plate 21, Figs. 12–14.)

Shell productiform in general aspect, somewhat depressed, not attached. On the pedicle-valve the cardinal area is prominently developed, frequently somewhat distorted; the delthyrium is closed by a convex deltidium which is covered with little tubercles or spinules. Cardinal teeth rudimentary or absent. In the brachial valve the cardinal area is linear, the cardinal process large, quadrifid; its base being surrounded by a strong deltidial callosity. Brachial ridges extending nearly to the anterior margin and abruptly incurving. Otherwise the interior impressions are as in PRODUCTUS. Surface of both valves thickly set with spines.

Type, *Aulosteges Wangenheimi*, De Verneuil.

Distribution. Permian.

Productus, Sowerby. 1812.

(Plate 22, Figs. 1–12.)

Shell free, concavo-convex, the valves usually produced anteriorly; outline semicircular, sometimes transversely elongate. Pedicle-valve convex, sometimes geniculated, occasionally with a median sinus. Cardinal extremities frequently auriculate. Umbo inflated, with apex incurved. Hinge-line straight, cardinal area and teeth absent or rudimentary. External surface usually with more or less prominent radiating ribs which are crossed, especially in the umbonal region, by concentric lines of wrinkles; rarely smooth or finely striated, often studded with spines varying in size and abundance. These spines are frequently scattered irregularly over the surface, generally strongest and disposed with greatest regularity upon the cardinal extremities, and sometimes occurring only in this region. They are hollow and appear to have communicated with the interior cavity of the shell. On the interior of the valve is a narrow median ridge, separating the two dendritic impressions of the adductor muscles; outside and in front of these are two broadly flabellate, longitudinally striated scars of the diductor muscles. In the pallial region are sometimes found traces of spiral cavities, which were occupied by the fleshy arms.

The brachial valve is operculiform, more or less concave or almost flat over the visceral area. Cardinal area, sockets and crural plates absent or rudimentary; cardinal process strong, curved or erect, extending far above the hinge-line; its inner face is divided into two lobes by a longitudinal furrow, and each of these parts is deeply divided at its extremity, giving the process in this aspect a quadrilobed appearance. As viewed from the posterior or outer face it is strongly trilobed, the inner members of the lateral lobes coalescing to form a very prominent apophysis. The process is continued over the interior of the shell as a longitudinal septum, dividing the impressions of the adductor muscles. The latter are strongly dendritic and rarely divisible into anterior and posterior elements. The brachial ridges take their origin from near the post-lateral margins and nearly inclose a sub-circular, smooth or granulose area. The internal surface of this valve is strongly pustulose, and in the pallial region frequently spinous. Shell substance fibrous, strongly punctate.

Type, *Productus semireticulatus*, Martin (sp.).

Distribution. Devonian (?) — Permian.

Subgenus **Productella**, Hall. 1867.

(Plate 21, Figs. 15–24.)

Shells small, productoid. Surface spinous. Pedicle-valve with narrow cardinal area, deltidium and small teeth. Brachial valve with sockets and crural plates.

(Type, *P. subaculeatus*, Murchison (sp.). Devonian.)

Subgenus **Marginifera**, Waagen. 1884.

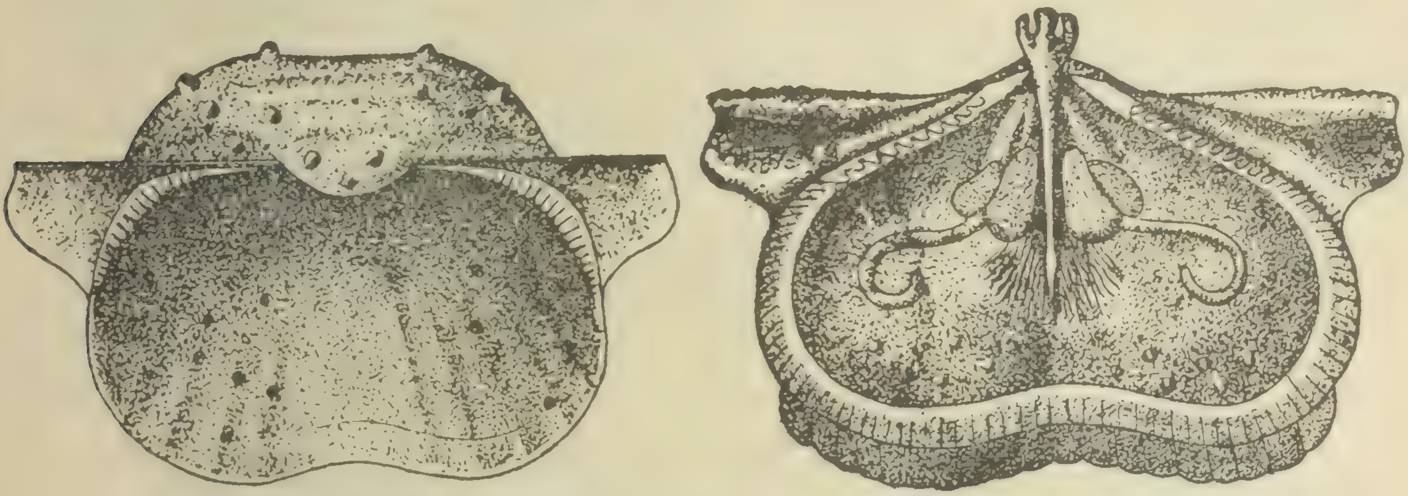
(Plate 22, Figs. 13–15.)

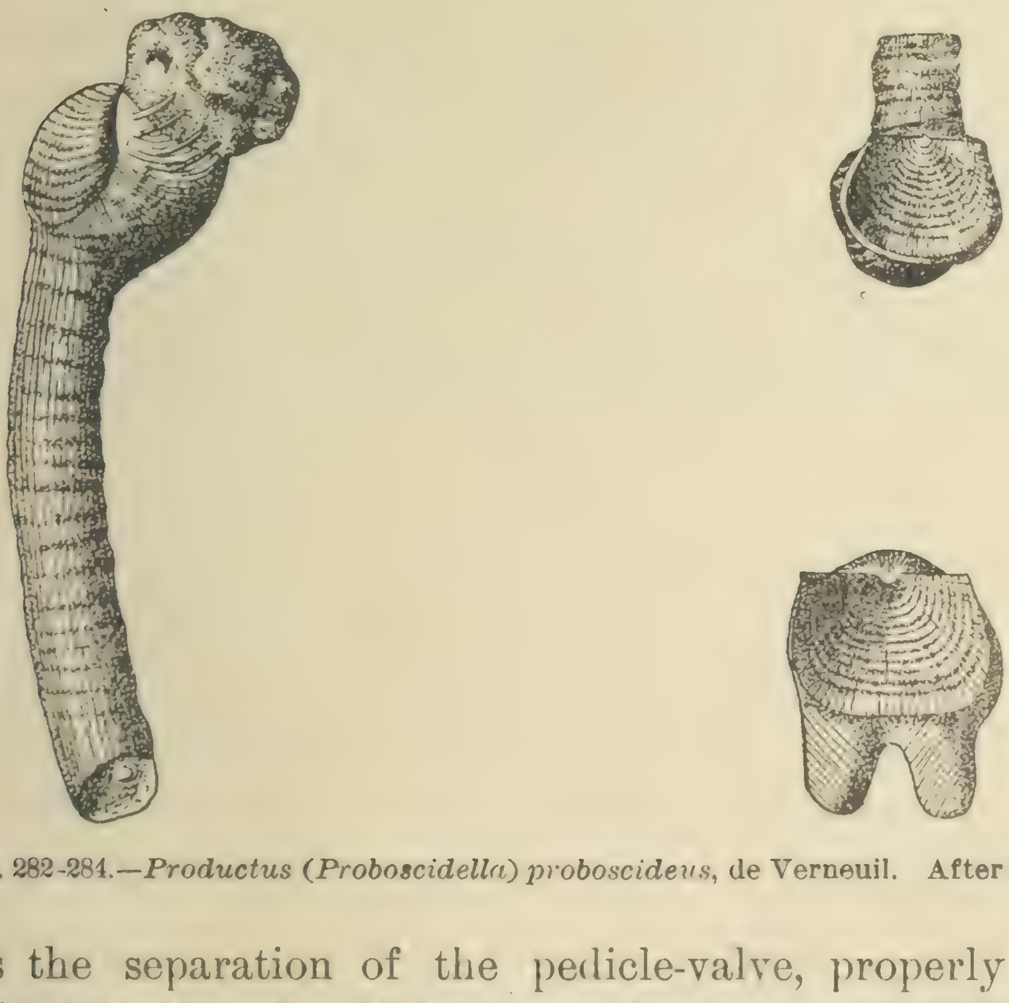
Externally like Productus. On the interior of the pedicle-valve are prominent shelf-like ridges on either side of the beak, extending inward and crenulated on their margins. There are similar but vertical ridges on the interior of the brachial valve.

(Type, *Marginifera typica*, Waagen. Devonian (?) to Permian.)

Subgenus **Proboscidella**, Œhlert. 1887.

Valves very unequal; the brachial valve small, concave, operculiform; the pedicle-valve larger, convex, furnished with two lateral expansions which bend downward to meet the margins of the brachial valve, and an anterior expansion which is produced forward into a long cylindrical tube, sometimes attaining twice the length of the shell; the suture appears on the dorsal side in the median line. Sometimes instead of a single tube there is a double enrollment resulting in two distinct tubes. The surface is ornamented by concentric plications, traversed by fine radiating ribs, which are flexuous and close together, the last plication, and the groove accompanying it, is sharper than the others and marks the separation of the pedicle-valve, properly speaking, from its lateral and anterior expansions upon which the concen-


FIGS. 280-281.—*Marginifera typica*, Waagen. After WAAGEN.

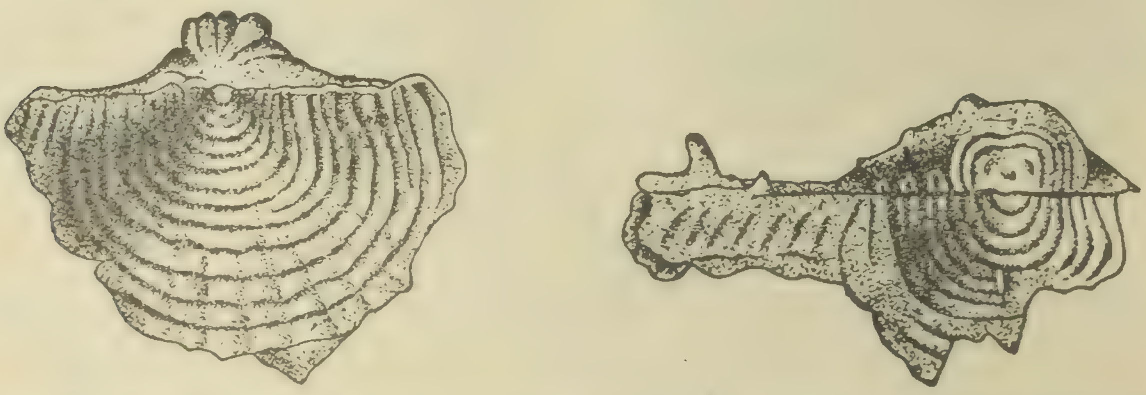

FIGS. 282-284.—*Productus (Proboscidella) proboscideus*, de Verneuil. After DE KONINCK.

tric markings are rare, faintly developed or wholly wanting, while the radiating striæ are regularly continued.

(Type, *P. proboscideus*, De Verneuil. Carboniferous.)

Subgenus **Etheridgina**, Œhlert. 1887.

Shells of very small size, nearly as broad as long, attached to foreign bodies by the spines of the pedicle-valve; cardinal line straight, nearly or quite equaling the greatest width of the shell; pallial outline semicircular; pedicle-valve with a small beak; surface ornamented by concentric flexuous plications, bearing a few scattered spines; cardinal process quadrifid.



FIGS. 285, 286.— *Productas (Etheridgina) complectens*, Etheridge. After ETHERIDGE.

(Type, *E. complectens*, Etheridge (sp.). Carboniferous.)

[NOTE.—The continuation of this present paper upon the Brachiopoda is already far advanced, and it is expected that it will be published in the Annual Report of the State Geologist for 1893. The second part will include the spire-bearing Genera, the Rhynchonelidæ, Pentameridæ and the Ferebratuloide.]

EXPLANATIONS OF PLATES.

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PLATE 1.

Legend.

p.	Pedicle-groove.
ps.	Pedicle sheath.
g.	Umbonal scars.
l.	Lateral scars.
k.	Middle laterals.
j.	Anterior laterals.
l.	Outside laterals.
x.	Concrete laterals.
h.	Central scars.
b.	Parietal scar.
cr.	Crescent.
i.	Transmedian scars.
d.	Cardinal area.
s.	Median septum.
s′.	Lateral septa.
sv.	Vascular trunks.
v.	Vascular branches.
cc.	Cardinal callosities.
pl.	Platform.

LINGULA, Bruguière.

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Lingula anatina, Lamarck.

Fig. 1. The interior of the pedicle-valve; showing the character of the muscular scars and septa as they appear when the muscular bands and the mantle are wholly removed. Natural size.

Fig. 2. Brachial valve of the same. Natural size.

Recent. *Philippine Islands.*

Lingula Elderi, Whitfield.

Figs. 3, 4. Copies of the lithographic figures given by Mr. Whitfield (Geol. Surv. Wisconsin, vol. iv, pl. 27, figs. 4, 5), of the interiors of the pedicle and brachial valves, respectively. Drawn from a cast which preserves the internal characters with remarkable completeness. × 2.

Trenton limestone. *Near Rochester, Minnesota.*

Lingula Philomela, Billings.

Fig. 5. A pedicle-valve (?), imperfect in the umbonal region; illustrating one extreme of outline attained by shells of this genus.

Trenton limestone. *Florenceville, Howard county, Iowa.*

Lingula Iowensis, Owen.

Fig. 6. The interior of a brachial valve; showing the conspicuously developed median septum, the well-defined central scars (h), and the progressive laterals (x).

Galena limestone. *Fountain, Minnesota.*

Lingula Covingtonensis, Hall and Whitfield.

Fig. 7. The exterior of a pedicle-valve; showing the suborbicular outline.

Hudson River group. *Near Cincinnati, Ohio.*

Lingula tæniola, Hall.

Fig. 8. The pedicle-valve; showing the peculiar surface ornamentation, crossed near the beak by concentric growth lines. × 1.5.
Clinton group. *Clinton, N. Y.*

Lingula lamellata, Hall.

Fig. 9. The exterior of the pedicle-valve.
Niagara group. *Lockport, N. Y.*

GLOSSINA, Phillips.

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Glossina acuminata, Conrad.

Fig. 10. A pedicle-valve from which most of the substance of the shell has been exfoliated, presenting a cast of the internal surface, which retains the impressions of the fine radiating, and coarser, more distinct, concentric lines. The thickness of the shell-substance and the undulating character of its laminæ is shown on the marginal portion of the figure, but no traces of muscular impressions are discernible. × 2.

Fig. 11. A brachial valve of the same species, from which the shell is partially exfoliated. × 2.
Calciferous sandstone. *Saratoga, N. Y.*

DIGNOMIA, Hall.

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Dignomia alveata, Hall.

Fig. 12. A cast of a brachial valve, showing the long, sharp median septum and the fainter diverging lateral septa. Natural size.
Hamilton shales. *Fultonham, N. Y.*

Fig. 13. A portion of the interior of a large pedicle-valve (?), with a shorter and broader median septum and distinct lateral septa. Natural size.
Hamilton shales. *Canandaigua Lake, N. Y.*

BARROISELLA.

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Barroisella subspatulata, Meek and Worthen.

Fig. 14. The interior of a pedicle-valve, showing the cardinal area, muscular and other markings. × 3.

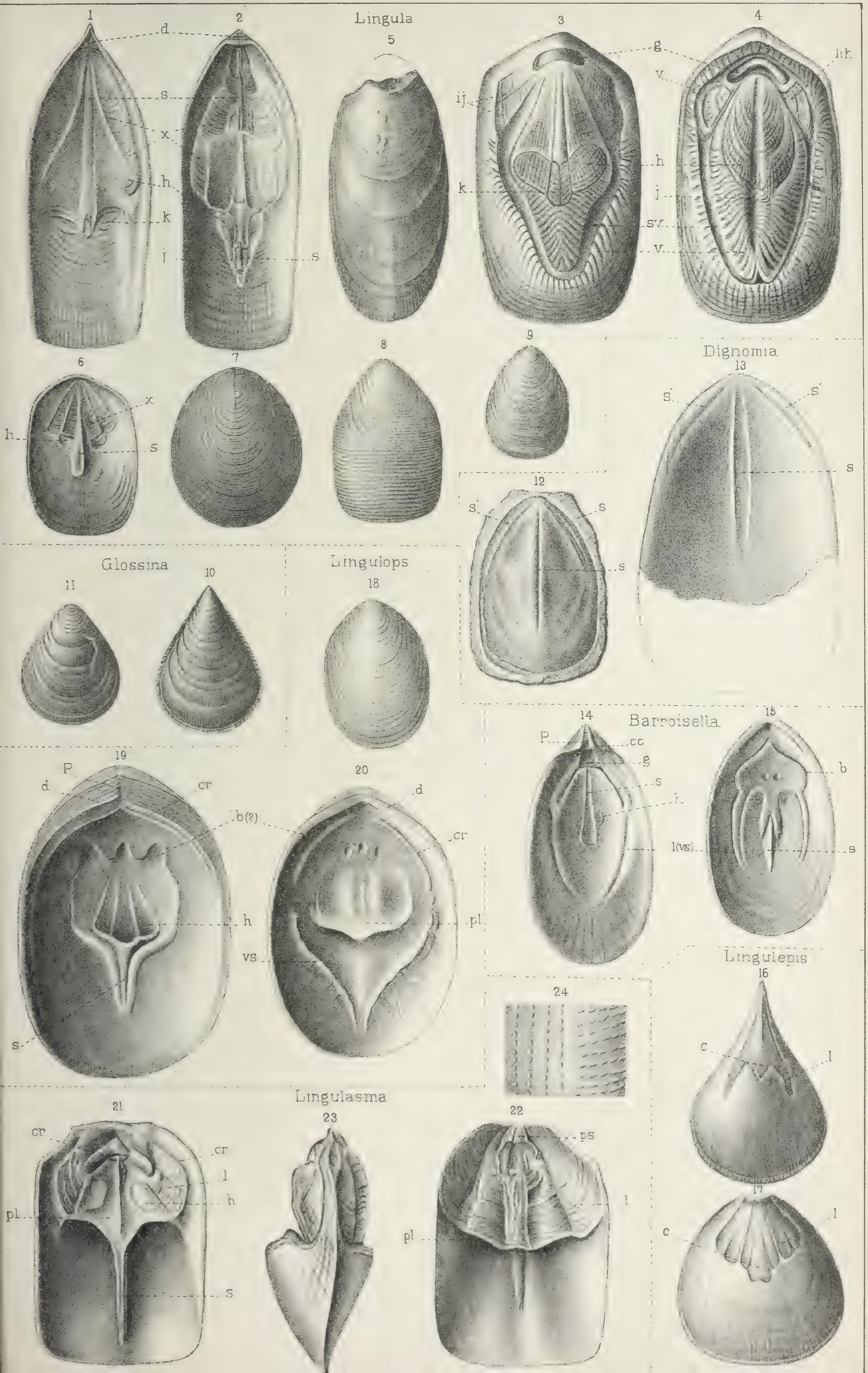
Fig. 15. The interior of a brachial valve, with characteristic features. × 3.
Black slate (Genesee slate). *White River, near Rockford, Indiana.*

BRACHIOPODA.

Generic Illustrations.

Report State Geologist, 1891.

Plate 1



LINGULEPIS, Hall.

Page 231.

Lingulepis pinniformis, Owen.

Fig. 16. An internal cast of a pedicle-valve; showing the faint median septum and the elongate muscular scar, with its lateral and central divisions. × 2.

Fig. 17. An internal cast of the brachial valve in which the muscular impression is flabellate, the central and lateral scars being quite distinct, the latter somewhat bilobed. × 2.

Potsdam Sandstone. *Falls of the St. Croix, Minnesota.*

LINGULOPS, Hall.

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Lingulops Whitfieldi, Hall.

Fig. 18. The exterior of a pedicle-valve. × 6.

Fig. 19. The interior of a pedicle-valve; the original specimen. The figure has been drawn from a gutta-percha impression of an internal cast, and shows the compound cardinal area, the inner portion of which is concentrically striated; the crescent (cr); the scalloped parietal scar and median muscular scars; the narrow longitudinal septum flanked by broad, rounded ridges continued from the visceral region. No traces of vascular impressions are visible on the specimen. × 12.

Fig. 20. The interior of the brachial valve, drawn from a gutta-percha impression; showing the double cardinal area, a faint pedicle-depression, the crescent (cr), the parietal (?) scars, the platform, and the vascular sinuses with their outer ramifications. × 10.

Hudson River group. *Maquoketa Creek,* 12 *miles north-west of Dubuque, Iowa.*

LINGULASMA, Ulrich.

Page 235.

Lingulasma Schucherti, Ulrich.

Fig. 21. The interior of a brachial valve; showing the character of the muscular impressions, the platform and the very strong septum. Drawn from a gutta-percha impression of an internal cast. Natural size.

Fig. 22. The interior of the pedicle-valve; showing the pedicle-sheath (ps), the indistinctly defined muscular impressions, the low platform and inconspicuous septum. This drawing is also made from a gutta-percha impression. Natural size.

Fig. 23. Profile view of an internal cast; showing the relative thickness of the platforms on the two valves.

Fig. 24. An enlargement of the surface ornamentation. The tubercles are sharply defined, and round on the median portions of the shell, but become elongated and less distinct toward the lateral margins. × 5.

Hudson River group. *Wilmington, Illinois.*

PLATE 2.

Legend.
a. Deltidium.
b. Deltidial slope.
c. Deltidial ridges.
cd. Cardinal area.
cr. Crescent.
d. Areal borders.
h. Cardinal buttress.
i. Umbonal chambers.
j. Platform.
k. Platform-vaults.
m. Median scars.
n. Anterior scars.
o. Lateral scars.
q. Crown of crescent.
r. Side of crescent.

DINOBOLUS, Hall.

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Dinobolus Conradi, Hall.

Fig. 1. An internal cast of a brachial valve, indicating very distinctly the muscular impressions and the minute platform-vaults.

Niagara limestone. *Grafton, Wisconsin.*

Fig. 2. The interior of a pedicle-valve; drawn from a gutta-percha impression taken from the specimen represented in fig. 3.

Fig. 3. An internal cast of the pedicle-valve: showing the filling of the chambers beneath the platform.

Fig. 4. The interior of a pedicle-valve, having the cardinal surface extremely developed. From a gutta-percha impression of a natural cast.

Niagara limestone. *Near LeClaire, Iowa.*

MONOMERELLA, Billings.

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Monomerella prisca, Billings.

Fig. 5. An internal cast of a pedicle-valve, in which the umbonal chambers have their usual length. The crescent and lateral scars of the platform are unusually distinct.

Fig. 6. An internal cast of a brachial valve: showing the characteristic markings of the shell.

Niagara limestone. *Hawthorne, Illinois.*

RHINOBOLUS, Hall.

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Rhinobolus Galtensis, Billings.

Fig. 7. The interior of a pedicle-valve; showing the narrow median, and broad lateral divisions of the cardinal surface, and the small, imperfectly developed platform. The drawing is made from a gutta-percha impression of a mold of the interior, the specimen being that originally taken as the type of the genus.

Guelph limestone. *Galt, Ontario.*

BRACHIOPODA.

Generic Illustrations.

Report State Geologist, 1891.

Plate 2.

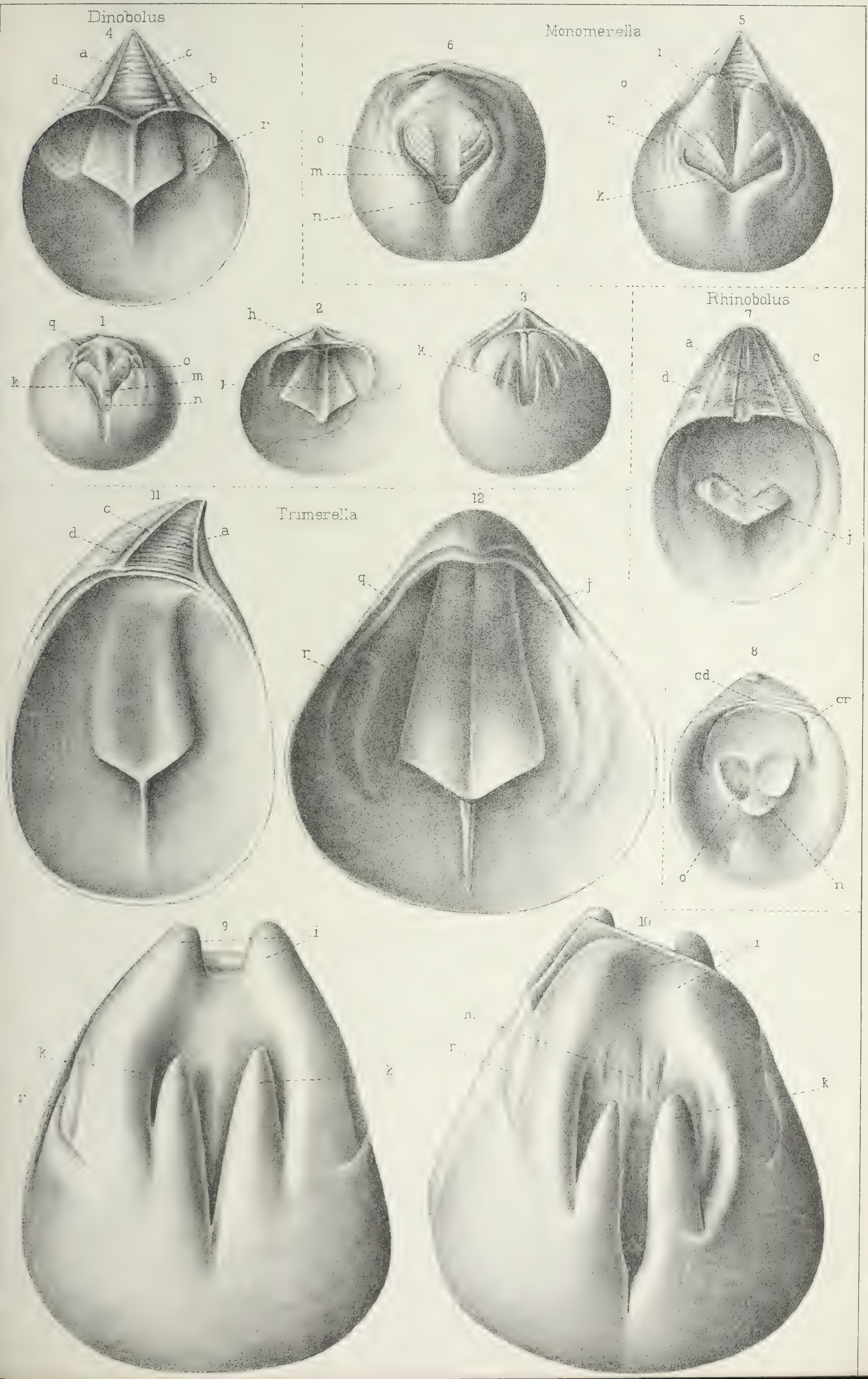

Fig. 8. The interior of a brachial valve; drawn from the specimens figured by WHITEAVES on plate 8, fig. 3, Palæozoic Fossils, vol. iii, pt. 1.
Guelph limestone. *Hespeler or Durham, Ontario.*

TRIMERELLA, BILLINGS.

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TRIMERELLA GRANDIS, Billings.

Fig. 9. An internal cast, viewed from the brachial side; showing the low umbonal chambers, the length of the platform-vaults and the lateral scars of the crescent.

Fig. 10. The reverse of the same specimen ; showing the much greater prominence of the umbonal chambers in this valve. The anterior margin and casts of the vaults have been slightly restored in the drawings.
Niagara group. *Near Sinking Spring, Ohio.*

TBIMERELLA OHIOENSIS, Meek.

Fig. 11. A small pedicle-valve ; showing a distortion of the umbo which extends to the posterior portion of the platform. The drawing is made from a gutta-percha impression, and the shell is somewhat restored in the umbonal region.
Niagara group. *Port Byron, Illinois.*

Fig. 12. A brachial valve ; showing the incurvature of the beak, the subumbonal ridge merging into the crescent, the broad lateral scars of the crescent, the long relatively narrow platform with its medially depressed surface, and the strong anterior septum. Drawn from a gutta-percha impression of a natural cast.
Niagara group. *Rising Sun, Ohio.*

PLATE 3.

Legend.
l. Laterals.
c'(h). Centrals.
sc. Subcardinals or post-medians.
cr. Crescent.
e. Externals.
x. Composite posteriors.
P. Pedicle-groove.
F. Foramen.
f. Foraminal pits.
s. Septum (median).
s'. Septum (lateral).
o. Vascular trunks (oviducts).
d'. Subapical area.
cb. Cardinal bosses.
fc. Foraminal callosity.

LINGULELLA, Salter.

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Lingulella cælata, Hall.

Fig. 1. A pedicle-valve from which the shell is partially exfoliated; showing traces of the curved lateral and the central scars. ×2.

Fig. 2. A pedicle-valve retaining most of the shell; (*a*) longitudinal section showing the elevation of the beak; (*b*) posterior elevation. ×2.

Fig. 3. A brachial valve; showing the central and lateral muscular impressions and a very sharply defined scar (*z*), which, if not adventitious, may be homologous with the external scars in Obolella or the terminal crescent scars in the Trimerellids. ×2.

Fig. 4. A portion of an internal cast of the brachial valve. ×2.

Middle Cambrian. *Near Troy, N. Y.*

OBOLELLA, Billings.

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Obolella crassa, Hall.

Fig. 5. The exterior of a valve; showing the radiating striæ between the lamellose growth-lines. × 2.

Fig. 6. The interior of the brachial valve; showing the faint pedicle-groove. the cardinal, external, central and lateral muscular impressions. × 2,

Fig. 7. The interior of a pedicle-valve; showing the pedicle-groove, the cardinal, lateral and central muscular scars. × 2.

Middle Cambrian. *Near Troy, N. Y.*

LEPTOBOLUS, Hall.

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Leptobolus insignis, Hall.

Fig. 8. The exterior of the shell; showing the concentric and radiating striæ. × 8.

Utica slate. *Middleville, N. Y.*

Fig. 9. An internal cast of the pedicle-valve; showing the long, curved lateral scars and a faint indication of the posterior muscular depression. × 10.

Utica slate. *Holland Patent, N. Y.*

Fig. 12. The interior of a pedicle-valve; showing the cardinal area and pedicle-groove, and the calloused fulcra of the lateral muscles. The posterior area is depressed and bears the impression of the central muscles on its pitted surface.

Hudson river group (Utica horizon). *Covington, Kentucky.*

LEPTOBOLUS LEPIS, Hall.

Fig. 10. The interior of a pedicle-valve; showing the cardinal groove and the diverging septa. × 12.

Fig. 11. The interior of the brachial valve; showing the grooved cardinal area and the median and lateral septa, each of which is bifurcate at its extremity. × 12.

Hudson River group. *Licking River, Ohio.*

ELKANIA, FORD.

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ELKANIA DESIDERATA, Billings (sp.).

Fig. 13. The interior of the pedicle-valve; showing the deep central impression, subcardinal, crescentic and external scars, the diverging vascular (genital?) furrows and the broad, deep lateral depressions, probably not of muscular origin. × 3.

Fig. 14. The interior of a brachial valve, with the impressions of the centra and lateral muscles and the crescent. × 3.

Quebec group. *Pointe Lévis.*

PATERULA, BARRANDE.

Page 242.

PATERULA (?), sp.

Fig. 15. The interior of a pedicle-valve, taken from a natural cast of the internal surface. The broad marginal border, narrow fissure and radiate muscular markings, indicate the close agreement of this fossil with PATERULA. × 5.

Quebec group. *South St. John's Market, Quebec.*

SCHIZOBOLUS, ULRICH.

Page 246.

SCHIZOBOLUS TRUNCATUS, Hall (sp.).

Fig. 16. The exterior of a pedicle-valve. × 3.

Fig. 17. The exterior of the brachial valve. × 3.

Genesee slate. *Western New York.*

Fig. 18. The interior of a pedicle-valve; showing the pedicle-slit, the composite muscular scars abutting against the median septum, and the long, curved lateral scars. × 5.

Fig. 19. The interior of the brachial valve; showing the septum and faintly defined muscular impressions. × 5.

Black slate (Genesee). *Madison county, Kentucky.*

DISCINOPSIS, MATTHEW.

Page 250.

DISCINOPSIS GULIELMI, Matthew.

Fig. 20. The exterior of a pedicle-valve?; showing the radiating and concentric lines, and a flattened apex which may indicate the position of the foramen. × 5.

Fig. 21. The interior of the pedicle-valve, with the linguiform median extension sharply defined, and showing the probable position of the foramen. × 5.

St. John group. *Portland, New Brunswick.*

LINNARSSONIA, WALCOTT.

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LINNARSSONIA TRANSVERSA, Hartt.

Fig. 22. The interior of a brachial valve; showing the median and lateral septa and the large posterior scars. × 10.

Fig. 23. The interior of a pedicle-valve; showing the inner aperture of the foramen, the foraminal callosity and the cardinal tubercles. × 10.

St. John group. *Porter's Brook, New Brunswick.*

ACROTHELE, LINNARSSON.

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ACROTHELE MATTHEWI, Hartt (sp.).

Fig. 24. The interior of a brachial valve; showing the median septum and adjacent muscular scars. × 3.

St. John group. *Portland, New Brunswick.*

ACROTHELE MATTHEWI, Hartt, var. LATA, Matthew.

Fig. 25. The interior of the pedicle-valve; showing the position of the foramen and the foraminal pits. × 3.

Fig. 26. An internal cast of the same valve. × 3.

ACROTHELE MATTHEWI, Hartt (sp.), var. PRIMA, Matthew.

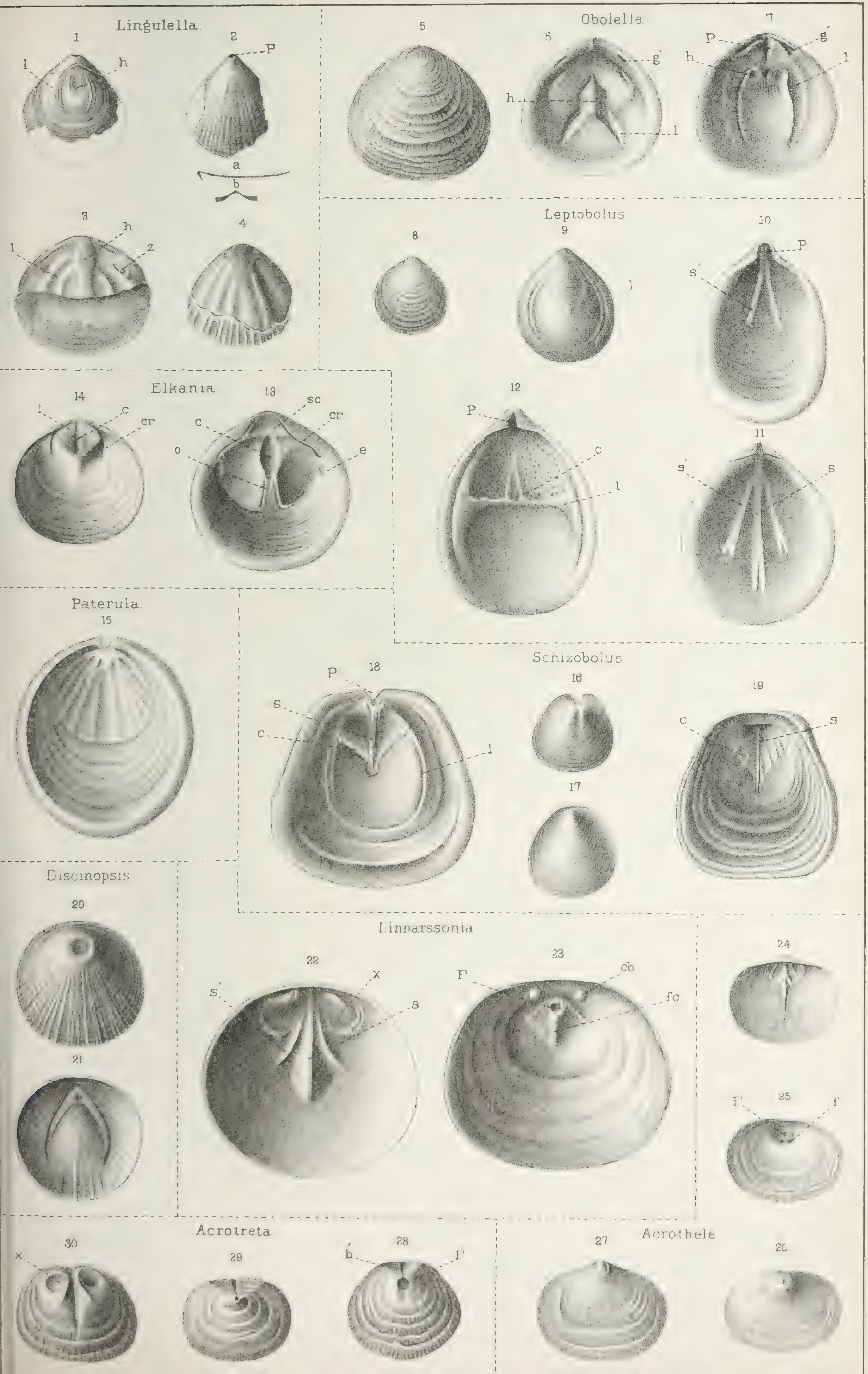
Fig. 27. The exterior of the pedicle-valve; showing the character of the surface ornamentation. × 3.

St. John group. *Hanford Brook, New Brunswick.*

BRACHIOPODA.

Generic Illustrations.

Plate 3.



ACROTRETA, Kutorga.

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Acrotreta Baileyi, Matthew.

Fig. 28. An internal cast of a pedicle-valve; showing the grooved subapical area and the impression of the nipple-like swelling surrounding the foramen. × 4.

Fig. 29. The exterior of a pedicle-valve; showing the size of the outer foraminal aperture. × 4.

Fig. 30. An internal cast of the brachial valve. × 4.

St. John group. *Long Reach, King's county, New Brunswick.*

PLATE 4.

Legend. x. Composite laterals.	F. Foramen.
c. Composite centrals.	P. Pedicle-groove.
cd. Cardinal ridge.	S. Sipho.

CONOTRETA, Walcott.

Page 250.

Conotreta Rusti, Walcott.

Fig. 1. An internal cast of a pedicle-valve; showing the impression of the strong apical callosity, and the radiating ridges. × 8.

Fig. 2. An apical view of the same valve; showing the subtriangular posterior slope, and its obscurely defined median furrow. × 9.

Fig. 3. Cardinal view of a very young individual, in which the posterior slope is very faint. × 12.

Trenton limestone. *Trenton Falls, N. Y.*

IPHIDEA, Billings.

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Iphidea bella, Billings.

Fig. 4. A pedicle-valve in which the subapical area is relatively small; showing the prominence of the cardinal ridge and the position of the foramen, which is not altogether distinct in the specimen. The figure is also slightly restored about the edges where the original is somewhat broken. × 3.

Fig. 5. Oblique view of the same, giving the elevation of the shell and the size of the cardinal ridge. × 3.

Georgia group. *Georgia, Vermont.*

HELMERSENIA, Pander.

Page 254.

Helmersenia, sp.?

Fig. 6. The interior of a pedicle-valve. The cardinal area is broad and bears a median depression or deltidium, as if for the passage of the pedicle.

Fig. 7. The exterior of a similar valve: showing the apical aperature which, according to Pander, is atrophied and blind. (Pander.)

BRACHIOPODA.

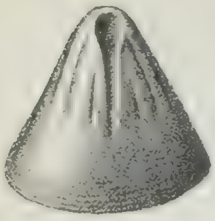
Generic Illustrations.

Report State Geologist, 1891

Plate 4.

Conotreta

1



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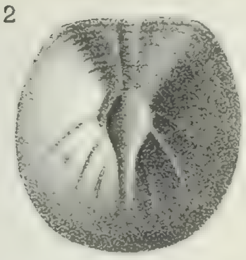

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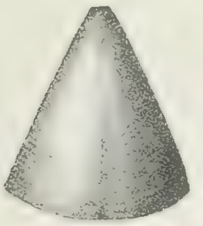
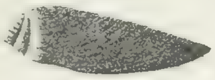


Iphidea

5



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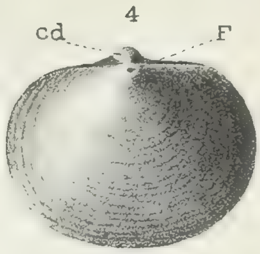

Helmersenia

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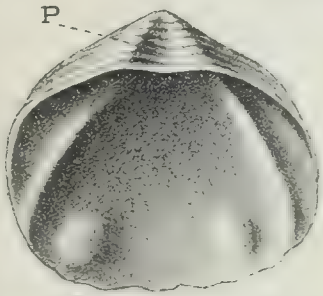

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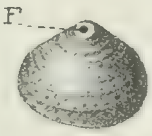

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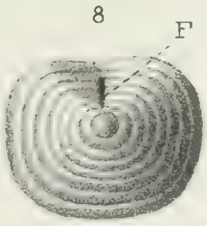

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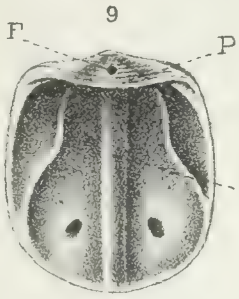

Keyserlingia

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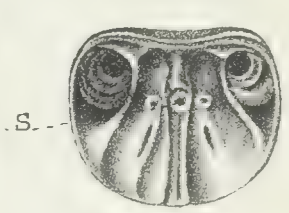
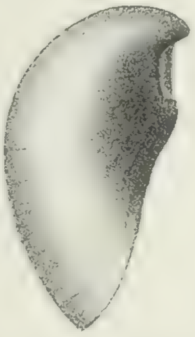


Kutorgina

12



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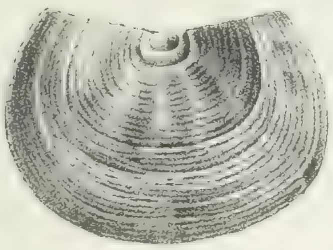

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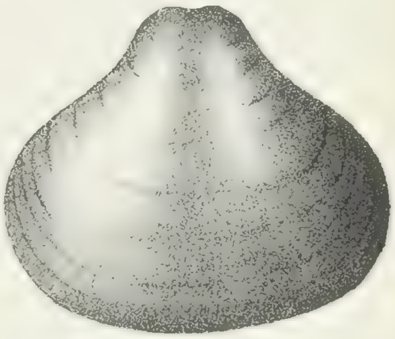
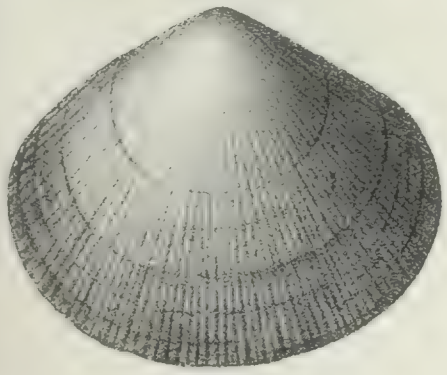


Monobolina

14



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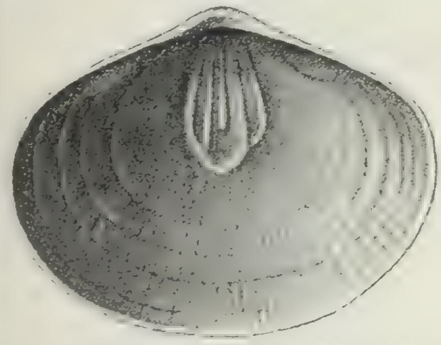

Schizambon

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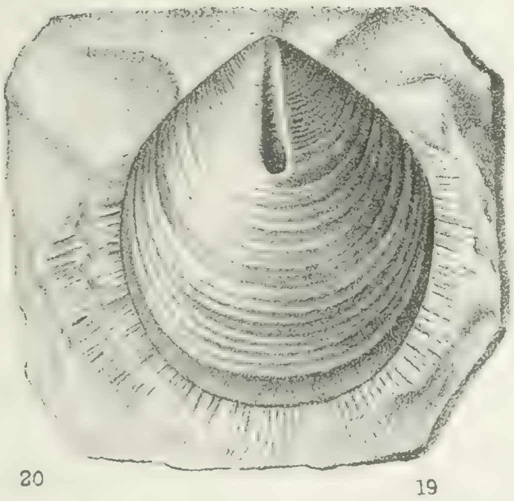

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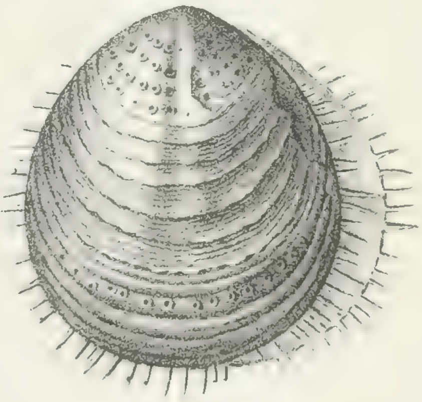

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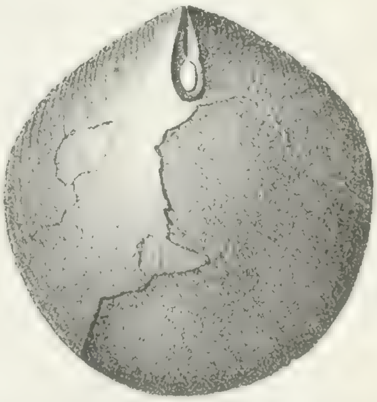

Mesotreta

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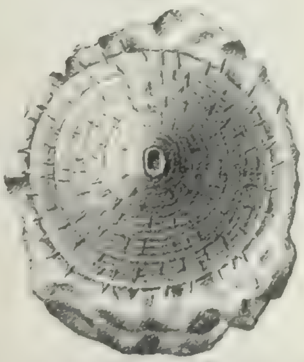

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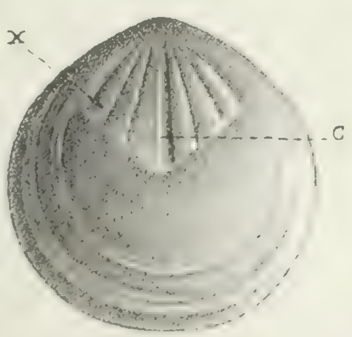

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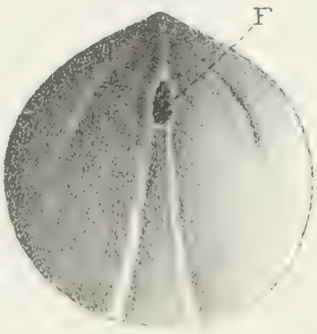

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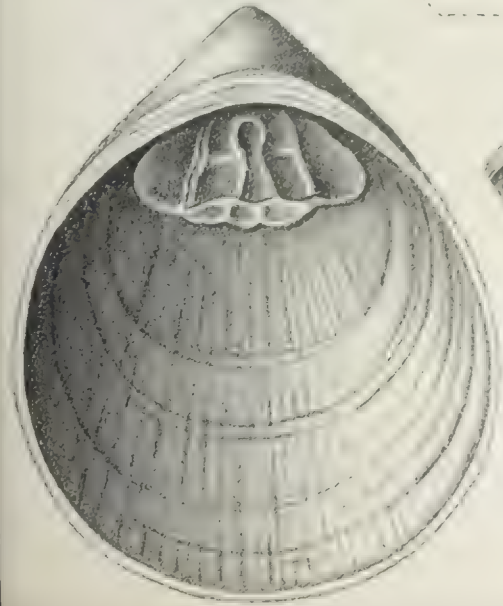

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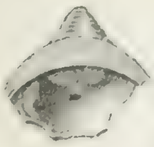

Siphonotreta

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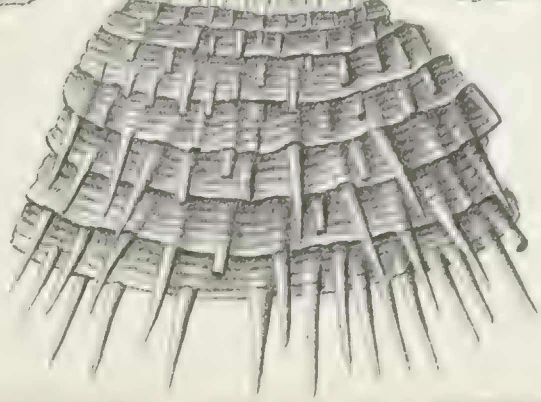

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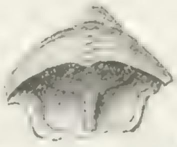

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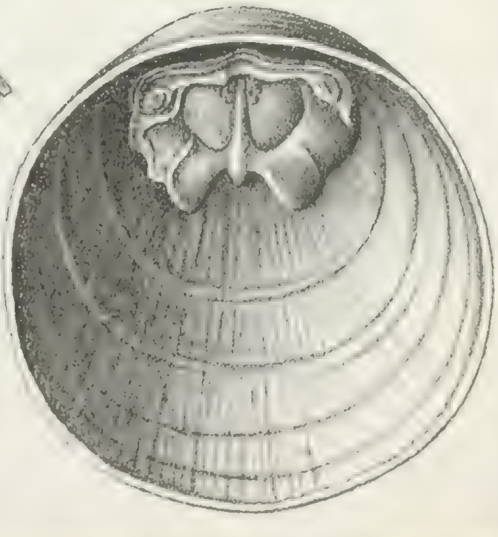

KEYSERLINGIA, PANDER, 1861,=ORBICELLA, D'ORBIGNY, 1849.

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KEYSERLINGIA BUCHI, De Verneuil.

Fig. 8. The exterior of the pedicle-valve; showing the slit-shaped opening of pedicle-passage.

Fig. 9. The interior of a pedicle-valve; showing the depressed or broadly grooved cardinal area, perforated by the opening of a sipho which is blind at its inner termination.

Fig. 10. The interior of a brachial valve; showing a blind internal tube, which is represented as broken, the cavity appearing in cross section.
Obolus beds. *River Ischora, Russia.*

The above figures are copies of those given by PANDER (Bull. de l'Acad. Imp. des Sciences de St. Petersbourg, vol. iii, p. 46, pl. ii, figs. 1, h, c, a), and represent the peculiar features assigned by him to the genus. The views are considerably enlarged.

KUTORGINA, BILLINGS.

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KUTORGINA CINGULATA, Billings.

Fig. 11. A pedicle-valve with strongly incurved umbo. × 3.

Fig. 12. Profile of the same.

Fig. 13. A brachial valve in which the cardinal margin is truncate from incurvation. × 2.
Georgia group. *Swanton, Vermont.*

MONOBOLINA, SALTER.

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MONOBOLINA PLUMBEA, Salter.

Fig. 14. Exterior of a brachial (?) valve. × 3.

Fig. 15. Interior of a similar valve. × 3. (DAVIDSON, Brit. Sil. Brach., pl. 1, figs. 23, 24.)

SCHIZAMBON, WALCOTT.

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SCHIZAMBON FISSUS (Kutorga), var. CANADENSIS, Ami.

Fig. 16. A pedicle-valve retaining some of the surface spines and showing the external character of the pedicle passage. × 2.
Utica slate. *Gloucester, Ontario.*

SCHIZAMBON MINNESOTENSIS.

Fig. 17. Dorsal view of a specimen retaining the valves in juxtaposition and preserving most of the epidermal layer of the shell. The spine-bases about the beak are noticeably large and more closely set than over the rest of the surface, where they occur at considerable intervals along the concentric varices. The entire length of the spines is evidently not represented in the fringe about the margin. × 2.

Trenton Limestone. *Minneapolis, Minnesota.*

SCHIZAMBON TYPICALIS, Walcott.

Fig. 18. The exterior of a pedicle-valve from which a portion of the shell has been lost. × 5. (WALCOTT.)

Fig. 19. The interior of a pedicle-valve; showing the oval foramen with the posterior depressed, track and diverging muscular ridges. × 5.

Fig. 20. The interior of a brachial valve; showing the muscular area and its subdivision by divergent ridges. × 5.

Lower portion of the Pogonip group. *Eureka District, Nevada.*

MESOTRETA, KUTORGA.

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MESOTRETA TENTORIUM, Kutorga.

Fig. 21. The exterior of the pedicle-valve; showing its conical shape, perforated apex and spinulose exterior. (KUTORGA.)

Lower Silurian. *Russia.*

SIPHONOTRETA, DE VERNEUIL.

Page 252.

SIPHONOTRETA UNGUICULATA, De Verneuil.

Figs. 22, 23. The interior characters of both valves as given by DAVIDSON. (Geological Magazine, 1877, pl. ii, figs. 9, 11.)

Fig. 24. A portion of the shell near the anterior margin, much enlarged to show the epidermal layer and the mode of origin of the hollow spines. (KUTORGA.)

Fig. 25. The cardinal portion of the pedicle-valve; showing the inner extension of the sipho which is open. (KUTORGA.)

Fig. 26. A similar portion of another valve in which the sipho is apparently closed. (KUTORGA.)

PLATE 5.

Legend. F. Foramen.
p. Pedicle-area.
p′. Areal callosity.
g, g′. Listrium.
l. Lateral walls of listrium.
ar. Anterior muscular ridges.
s. Median septum.
aa. Anterior adductor scars.

SCHIZOTRETA, KUTORGA.

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SCHIZOTRETA OVALIS, Hall.

Fig. 1. A pedicle-valve from which the shell has been partially broken; showing the short foraminal groove. × 3.

Fig. 2. Profile view of the same specimen; showing the convexity of the conjoined valves. × 3.
Trenton limestone. *Middleville, N. Y.*

SCHIZOTRETA CONICA, Dwight.

Fig. 3. Outline profile of the conjoined valves. After DWIGHT.

Fig. 4. The external characters of the pedicle-area. × 3.
Trenton limestone. *Newburgh, N. Y.*

ŒHLERTELLA, HALL.

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ŒHLERTELLA PLEURITES, Meek. (sp.)

Fig. 5. The interior of a pedicle-valve; showing the elevated pedicle ridge and the open marginal foramen.

Fig. 6. A profile of the same; showing the internal elevation of the pedicle-area.

Fig. 7. Exterior of a brachial valve; showing the posterior position of the apex.

Fig. 8. The internal characters of the pedicle-area; showing the open marginal foramen, the elevated, radially striated lateral walls, and the median ridge of the listrium and a short apical septum. × 3.
Waverly group. *Newark, Ohio.*

RŒMERELLA, HALL.

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RŒMERELLA GRANDIS, Vanuxem.

Fig. 9. The exterior of a brachial valve.
Hamilton limestone. *Falls of the Ohio.*

Fig. 10. The exterior of a pedicle-valve from which the shell has been partially exfoliated, exposing the cast of the external pedicle-groove.
Hamilton group. *Cazenovia, N. Y.*

ORBICULOIDEA, D'ORBIGNY.

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ORBICULOIDEA PULCHRA, Hall.

Fig. 11. The exterior of a pedicle-valve. × 1.5.

Fig. 17. The interior portion of the pedicle-area; showing the callosites which have enveloped the various divisions of the area.
Cuyahoga shale. *Berea, Ohio.*

ORBICULOIDEA MANHATTANENSIS, Meek and Hayden.

Fig. 12. The interior of a pedicle-valve; showing the character of the pedicle-area, the radiating vascular lines, and where the shell is broken on the anterior portion, the character of the external ornamentation and the unusual thickness of the valve.
Coal measures. *Riley county, Kansas.*

ORBICULOIDEA MEDIA, Hall.

Fig. 13. The exterior of a pedicle-valve.
Chemung group. *Troupsburg, N. Y.*

Fig. 14. The exterior of a brachial valve.
Hamilton group. *Seneca county, N. Y.*

ORBICULOIDEA RANDALLI, Hall.

Fig. 15. The exterior of a pedicle-valve; showing, from compression, the apical muscular ridge, the radiating pallial sinuses and the internal track of the pedicle-furrow extending toward the margin and interrupting the concentric growth-lines. The overlapping marginal portion of the opposite valve is seen about the posterior arc of the circumference. Natural size.
Hamilton group. *Near Schoharie, N. Y.*

ORBICULOIDEA NITIDA, Phillips.

Fig. 16. The pedicle-area of an extremely young shell, having a diameter of 1 mm. The foramen is a marginal slit extending, with divergent edges, for almost the entire radius of the valve. At the apex, the listrium appears in an incipient stage. × 50.
Lower Coal measures. *Springfield, Illinois.*

LINDSTRŒMELLA, HALL,

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LINDSTRŒMELLA ASPIDIUM, Hall.

Fig. 18. The interior of a brachial valve; showing the great lateral ridges and low median septum. At the posterior extremities of the former are seen two small subcircular muscular impressions, while the scars of the anterior adductors are strongly developed. Natural size.
Hamilton group. *Near Hamilton, N. Y.*

BRACHIOPODA.

Generic Illustrations.

Plate 5.

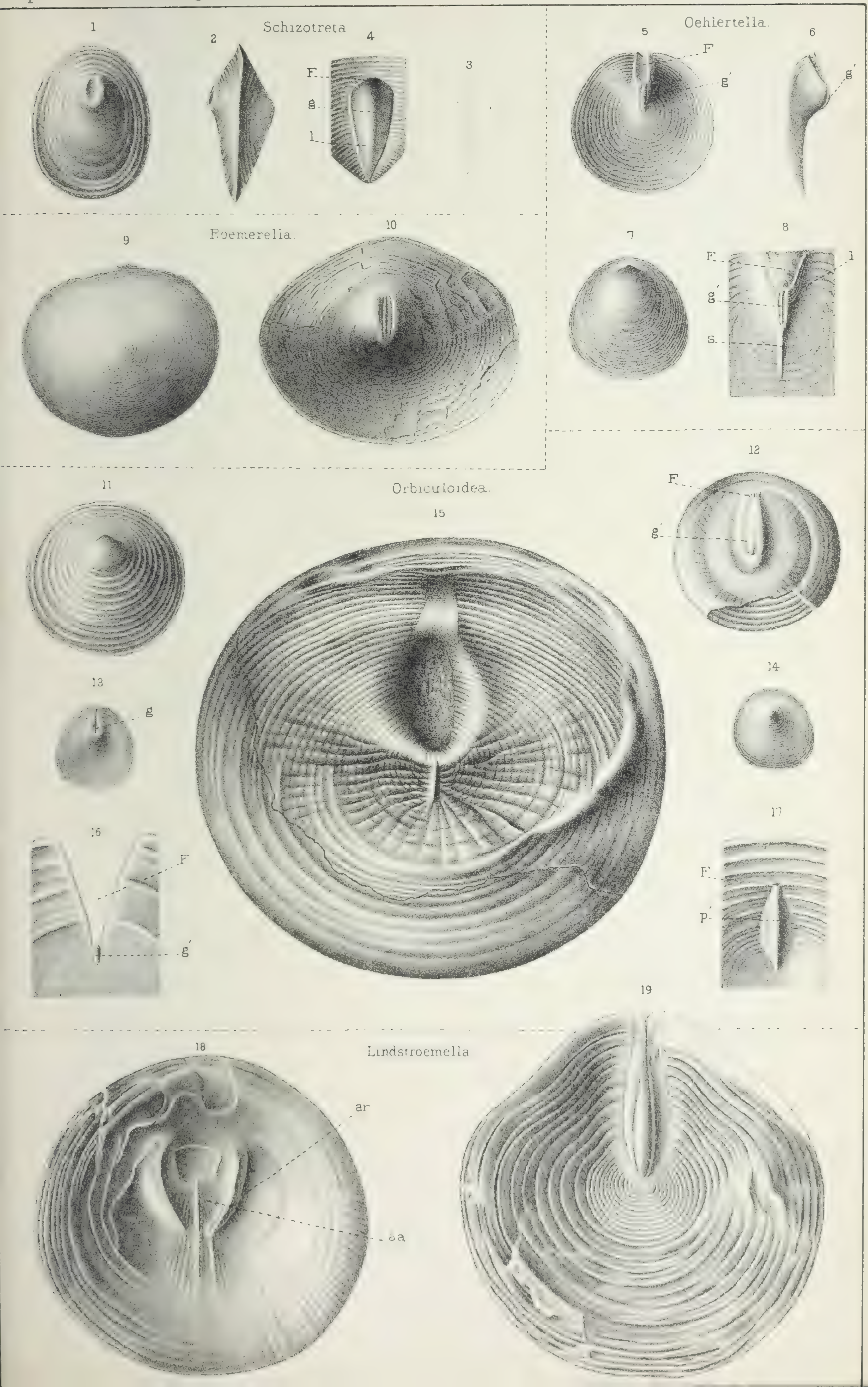

Fig. 19. A natural cast of the exterior of a large pedicle-valve believed to belong to this species; showing the character of the surface ornamentation, and the peculiar undulation of the concentric ridges on approaching the pedicle-area. The pedicle-passage differs from that in the normal mature ORBICULOIDEA, in not being closed, though its margins appear to be in contact. The characters of this area as represented in the drawing, have been slightly restored from other specimens.

Hamilton group. *Near Leonardsville, N. Y.*

PLATE 6.

Legend. B. Brachial valve.
P. Pedical-valve.
F. Foramen.
g, g′. Listrium.
l. Walls of listrium.
s. Medianse ptum.
o. Posterior muscular scars.
re. Extremital scars.
b. Brachial muscular scars.
m. Median muscular fulcrum.
c. Central scars.
pc. Posterior centrals.
cc. Median centrals.
ac. Anterior centrals.
pa. Posterior adductors.
pa′. Anterior element of posterior adductors.
aa. Anterior adductors.
v. Vascular sinuses.

TREMATIS, Sharpe.

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Trematis terminalis, Emmons.

Fig. 1. An internal cast of the pedical-valve; showing the great depression of the pedicle-area, the median ridge corresponding to the pedicle-groove, and the vascular sinuses. × 3.
Trenton limestone. *Middleville, N. Y.*

Trematis millipunctata, Hall.

Fig. 2. The exterior of a brachial valve, from which the shell is partially exfoliated. × 2.

Fig. 3. Profile of an internal cast of the conjoined valves.

Fig. 4. Ventral view of the same specimen, exposing the pedicle-valve and the projecting apical portion of the brachial valve. × 2.
Hudson River group. *Cincinnati, Ohio.*

Fig. 5. The interior of a brachial valve; showing the posterior callosity forming a surface for the passage of the pedicle, the external muscular scars and the components of the central impressions. × 2.
Hudson River group. *Covington, Ky.*

Fig. 6. The external ornamentation. × 25.

Trematis, sp., compare T. punctostriata, Hall.

Fig. 7. The internal pedicle-area; showing the elevation of the margins of the fissure. × 4.
Hudson River group. *Frankfort, Ky.*

Trematis Ottawensis, Billings.

Fig. 8. External view of a brachial valve. From a gutta-percha cast of the exterior. Natural size.
Trenton horizon. *Frankfort, Ky.*

BRACHIOPODA.
Generic Illustrations.

Report State Geologist, 1891.

Plate 6.

Trematis.

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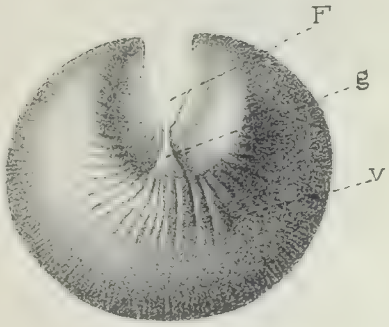

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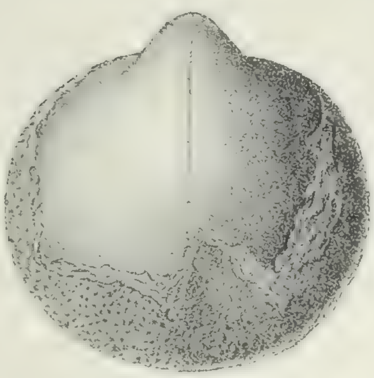

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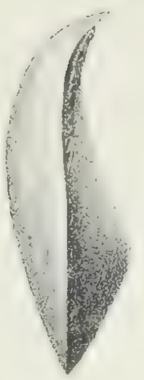

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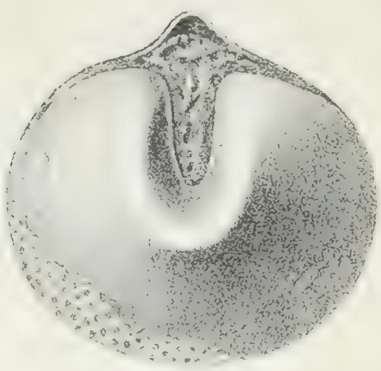

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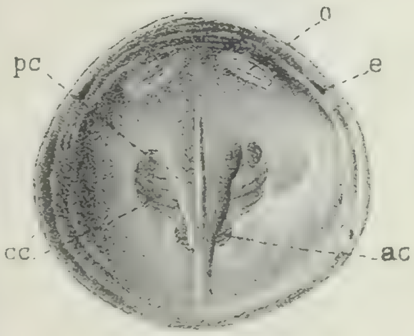

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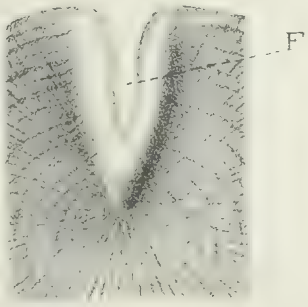

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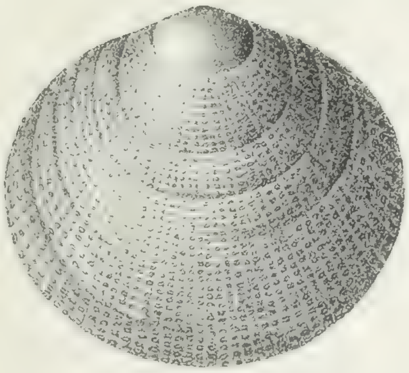

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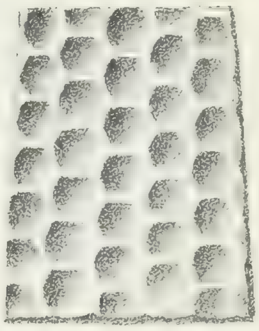

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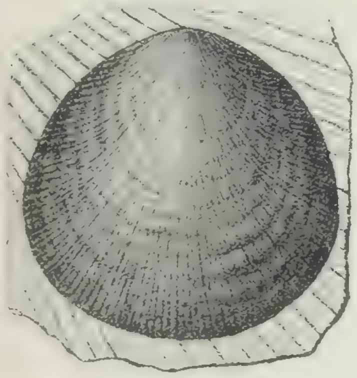

Schizocrania

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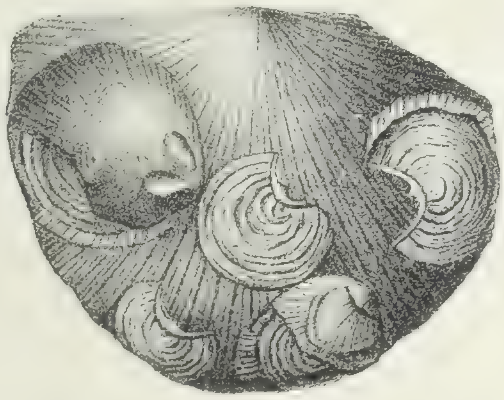

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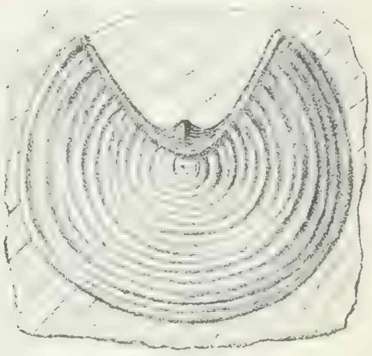

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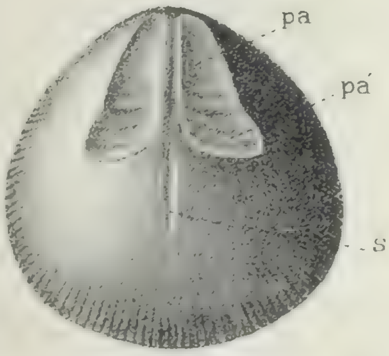

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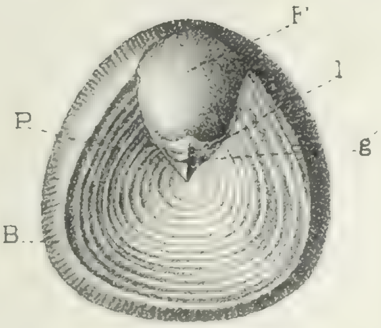

Crania

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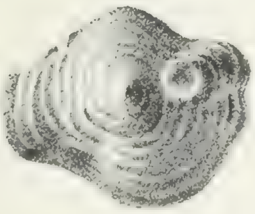

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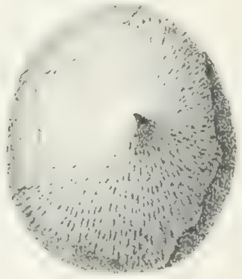

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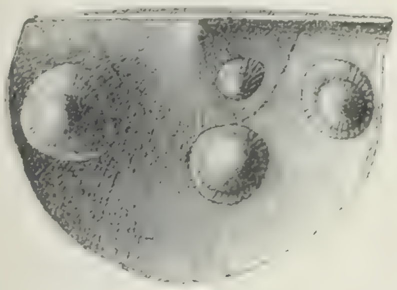

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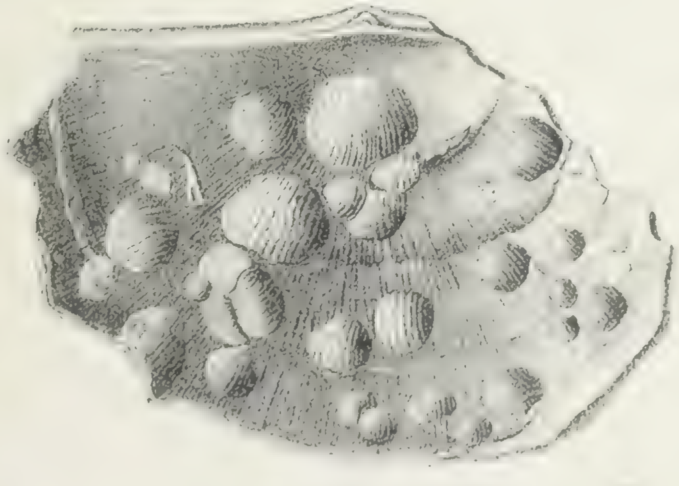

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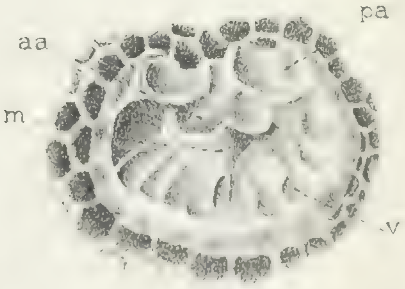

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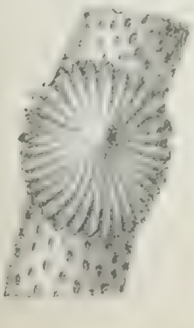

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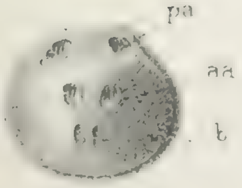

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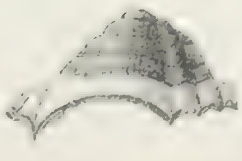

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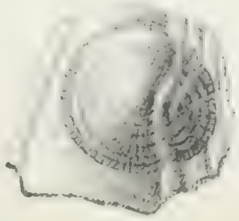

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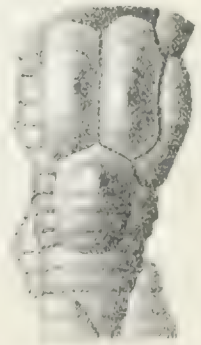

SCHIZOCRANIA, Hall and Whitfield.

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Schizocrania filosa, Hall.

Fig. 9. The exterior of a brachial valve attached to *Rafinesquina alternata.*

Fig. 10. A valve of *Rafinesquina alternata* to which five of these shells are attached, all of them exposing the lower valve.

This figure is taken from the Palæontology of Ohio, vol. ii, pl. i, fig. 12, and the muscular scars on the internal cast of the upper valve, shown in the left of the figure, remain as there represented.

Fig. 11. The pedicle-valve; showing the wide incision and the apical callosity.

Fig. 12. An internal cast of the brachial valve; showing the elongate muscular scars separated into anterior and posterior elements; also a faint median ridge extending forward beyond the muscular area.

Hudson River group. *Cincinnati, Ohio.*

Fig. 13. An individual from which the upper portion of the brachial valve has been removed, exposing all the internal characters of the pedicle-valve.

It will be observed that in this figure, as well as in fig. 10, the diameter of the lower valve is less than that of the upper, and as the former lies above and within the margin of the latter, the attachment of the shell being largely effected by the marginal portions of the larger valve.

Hudson River group. *Covington, Ky.*

CRANIA, Retzius.

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Crania granosa, Hall.

Fig. 14. A somewhat distorted upper valve, showing the finely granulose surface.

Hamilton group. *Centerfield, N. Y.*

Crania setifera, Hall.

Fig. 15. A somewhat imperfect upper valve.

Niagara group. *Waldron, Ind.*

Crania Lælia, Hall.

Fig. 16. Four individuals attached to the pedicle-valve of *Strophomena planumbona.*

Hudson River group. *Oxford, Ohio.*

Crania scabiosa, Hall.

Fig. 17. A brachial valve of *Rafinesquina alternata*, covered with shells of this species, all of which carry the radiating and fine concentric ornamentation of the host.

Hudson River group. *Cincinnati, Ohio.*

CRANIA FAVINCOLA, Hall.

Fig. 18. A lower valve, slightly broken about the posterior margin, but showing the very large posterior muscular impressions, the deeply impressed anteriors, with sharply elevated margins and median fulcrum; also the radiating pallial sinuses. The shell is attached to a specimen of *Favosites pirum*, Davis.

Hamilton group. *Crab Orchard, Ky.*

CRANIA PULCHELLA, Hall.

Fig. 19. An individual attached to a branch of *Trematopora*; showing the coarse radiating ribs. × 2.

Lower Helderberg group. *Near Clarksville, N. Y.*

CRANIA LEONI, Hall.

Fig. 20. The interior of an upper valve; showing, in addition to the posterior and anterior adductor scars, the faint impressions of the brachial muscles.

Chemung group. *Leon, N. Y.*

CRANIA BORDENI, Hall and Whitfield.

Fig. 22. An individual attached to a valve of *Spirifer Oweni*; showing the very fine radiating striæ, and the conformation of the upper valve to the surface of attachment.

Fig. 21. Profile of the same specimen.

Hamilton limestone. *Clarke county, Ind.*

CRANIA SOCIALIS, Ulrich (= *Crania scabiosa*, Hall).

Fig. 23. A fragment of a crinoid column, covered with individuals which retain very distinctly the impressions of the sutures between the segments. × 3.

Hudson River group. *Covington, Ky.*

PLATE 7.

Legend. pa. Posterior adductors.
aa. Anterior adductors.
da. Dorsal adjustors.
va. Ventral adjustors.
mm. Mesenteric muscular impressions.
p. Parietal impression.
m. Median impression.
b. Brachial muscular impression.
v. Vascular trunks.
v′. Vascular branches.

ANCISTROCRANIA, Dall.

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Ancistrocrania Parisiensis, Defrance.

Fig. 1. The interior of the attached valve.

Fig. 2. The interior of the upper valve. (Œhlert.)
Cretaceous. *France.*

CRANISCUS, Dall.

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Craniscus tripartitus, Münster.

Fig, 3. The interior of the attached valve; showing the divisions of the internal chamber. (Davidson.)
Jurassic.

CRANIELLA, Œhlert.

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Craniella Hamiltoniæ, Hall.

Fig. 4. An internal cast of a large upper valve; showing the usual muscular scars and the peculiar sigmoid vascular trunks with their ramifications.
Hamilton group. *Pratt's Falls, N. Y.*

Fig. 5. An internal cast of a convex and apparently free lower valve; showing the closer approximation of the anterior and posterior adductor scars than in the opposite valve, the deep impression of the mesenteric muscle, and the radiating vascular sinuses. The figure is slightly restored on the left side. × 2.
Hamilton group. *Centerfield, N. Y.*

Fig. 6. The interior of an attached valve. From Palæontology of New York, vol. iv, pl. iii, fig. 23.

Fig. 7. Profile view of a normal shell, attached to *Tropidoleptus carinatus.*
Hamilton group. *Canandaigua Lake, N. Y.*

Craniella Ulrichi. Hall.

Fig. 8. The internal cast of an upper valve. The sigmoid vascular impressions are simpler than elsewhere observed; the scars of the dorsal adjustors and of muscles accessory to the anterior adductors (possibly the brachial muscles) are also apparent.
Drawn from a gutta-percha cast of a natural interior. × 1.5.
Trenton limestone. *Minneapolis, Minnesota.*

CARDINOCRANIA, WAAGEN.

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CARDINOCRANIA INDICA, Waagen.

Figs. 9, 10. Interiors of attached valves. (Waagen.)
Carboniferous group. *India.*

PSEUDOCRANIA, McCOY.

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PSEUDOCRANIA DIVARICATA, McCoy.

Fig. 11. The exterior of the shell.

Fig. 12. The interior of a ventral (?) valve.

Fig. 13. The interior of the opposite valve. (DAVIDSON.)
Lower Silurian. *Great Britain.*

PHOLIDOPS, HALL.

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PHOLIDOPS HAMILTONIÆ, Hall.

Figs. 14, 15. Ventral (?) and profile views of conjoined valves.

Fig. 16. The interior of a ventral (?) valve; showing the character of the muscular impressions. × 8.

Fig. 17. The interior of the opposite valve; showing the muscular and parietal scars. × 4.
Hamilton group. *Canandaigua Lake, N. Y.*

PHOLIDOPS CINCINNATENSIS, Hall.

Fig. 18. The exterior of a normal specimen. × 4.
Hudson River group. *Cincinnati, Ohio.*

PHOLIDOPS LINGULOIDES, Hall. (?)

Fig. 19. The interior of a dorsal (?) valve: showing the terminal and slightly deflected beak, the subapical area and the character of the muscular scars. × 2.
Hamilton group. *Eighteen Mile Creek, N. Y.*

PHOLIDOPS AREOLATA, Hall.

Fig. 20. An internal cast of the dorsal (?) valve. × 3.
Schoharie grit. *Knox, N. Y.*

Fig. 21. An internal cast of the opposite valve. × 3.
Schoharie grit. *Near Clarksville, N. Y.*

PHOLIDOPS CALCEOLA, Hall.

Fig. 22. The interior of a dorsal (?) valve: showing the terminal beak: subapical area and the character of the muscular impressions. × 12.
Corniferous limestone. *Falls of the Ohio.*

BRACHIOPODA.

Generic Illustrations.

Report State Geologist, 1891. Plate 7.

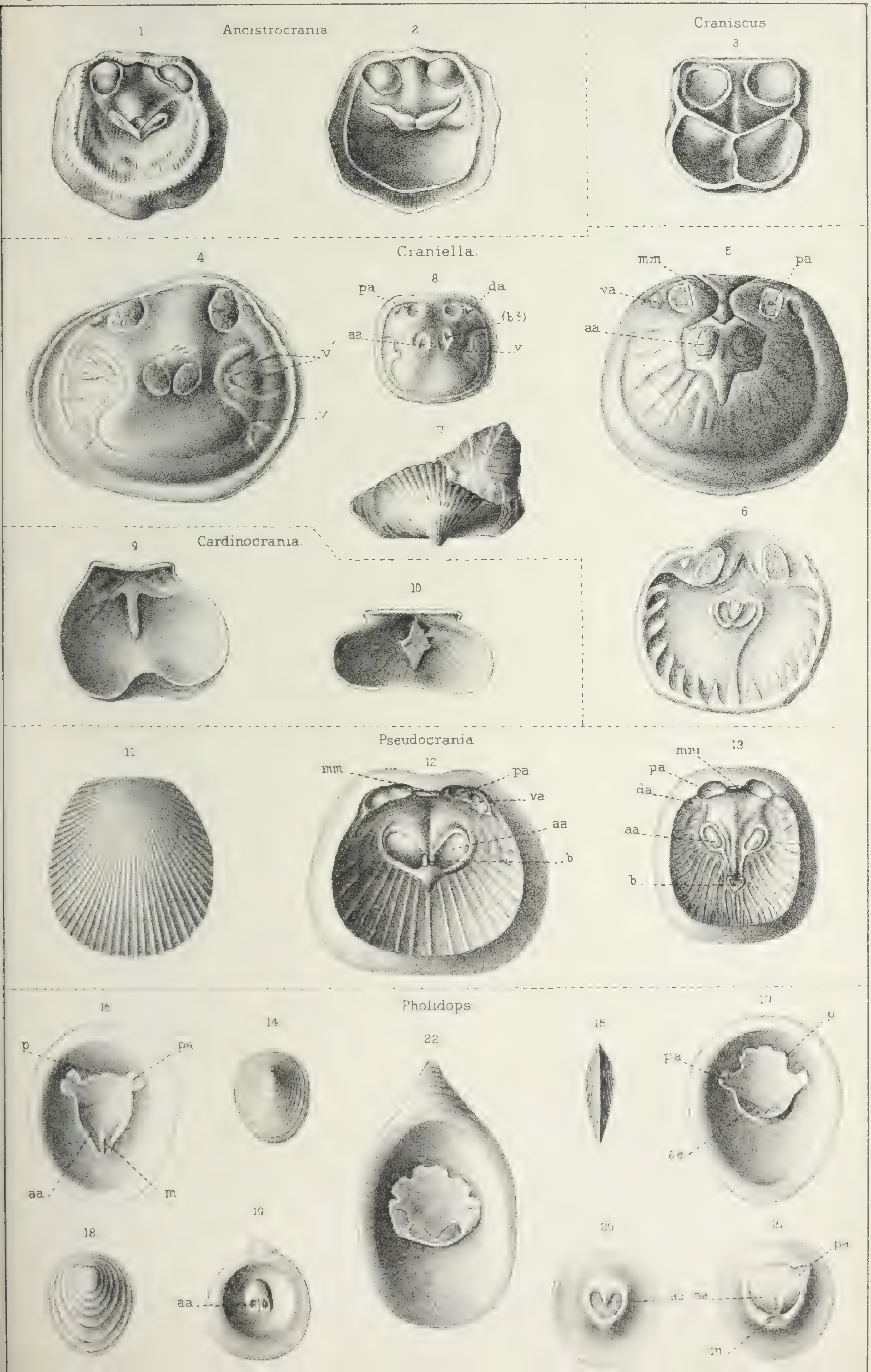

PLATE 8.

Legend. D. Deltidium.
j. Cardinal process.
t. Teeth.
l (d). Spondylium.
fp. Crual plates.
c. Crura.
DA. Cardinal area, brachial valve.
VA. Cardinal area, pedicle-valve.
F. Foramen.
C. Chilidium.
s. Median septum.
s′. Lateral septum.
s″. Accessory lateral septum.
a. Anterior adductor impressions.
a′. Posterior adductor impressions.
d. Dental lamellæ.

BILLINGSELLA, Hall.

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Billingsella Pepina, Hall.

Fig. 1. The interior of the pedicle-valve showing the broad cardinal area, the convex deltidium, teeth, outline of the muscular area and a single pair of vascular trunks. × 3.

Fig. 2. The interior of a brachial valve; showing the minute, linear cardinal process, and the small, slightly divergent crural plates. × 3.

Potsdam sandstone. *Lake Pepin, Wisconsin.*

PROTORTHIS, Hall.

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Protorthis Billingsi, Hartt.

Fig. 3. The exterior of a small pedicle-valve; showing the concave plate or spondylium which closes the delthyrium below. × 3.

Fig. 4. A cardinal view of the same specimen. × 3.

Fig. 5. The exterior of a pedicle-valve. × 2.

Fig. 6. The central cardinal portion of the brachial valve; showing the broad delthyrium with a thickened area at its base, and the absence of a cardinal process. × 6.

Fig. 7. The interior of a brachial valve. × 2.

St. John group. *Ratcliff's mill, near St. John, New Brunswick*

CLITAMBONITES, Pander.

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Clitambonites adscendens, Pander.

Fig. 8. A cardinal view, giving the subpyramidal contour characterizing this genus; showing also the foramen in the deltidium. × 2.

Fig. 9. A pedicle-valve with the apex cut away; showing the peculiar internal construction of this valve. × 2.

Lower Silurian. *Russia.*

CLITAMBONITES (ORTHISINA) ANOMALA, Schlotheim.

Fig. 10. A view of the pedicle-valve; showing the great restrorsion of the apex, the high cardinal area of the pedicle-valve, and the perforated deltidium; and also the area and chilidium of the opposite valve. (After DE VERNEUIL, Géol. Russ. et des Mont. de l'Oural, plate xii, fig. 2*b*.)

Fig. 11. The interior of a pedicle-valve. (After DAVIDSON.)

Fig. 12. The interior of the brachial valve; showing the extreme development of the cardinal area and chilidium, the latter entirely obscuring the cardinal process; the character of the muscular and vascular scars is also distinctly seen. (After DAVIDSON.)

Lower Silurian. *Russia.*

CLITAMBONITES VERNEUILI, (von Eichwald) Billings.

Fig. 13. The interior of a pedicle-valve, showing the simple cardinal process abutting against the chilidium, and the quadripartite impression of the adductor muscles.

Trenton horizon. *Island of Anticosti.*

HEMIPRONITES, PANDER.

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HEMIPRONITES, sp. ?

Fig. 14. A cardinal view of conjoined valves; showing the characteristic contour upon which is based the separation of these forms from CLITAMBONITES. × 2.

Fig. 15. A specimen cut horizontally across the umbonal region of the pedicle-valve; showing the united dental lamellæ supported by a median septum. × 2.

Lower Silurian. *Russia.*

POLYTŒCHIA, HALL.

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POLYTŒCHIA APICALIS, Whitfield.

Figs. 16, 17, 18. Three views of the original specimens of the species, the last showing the high cardinal area and convex deltidium. × 3.

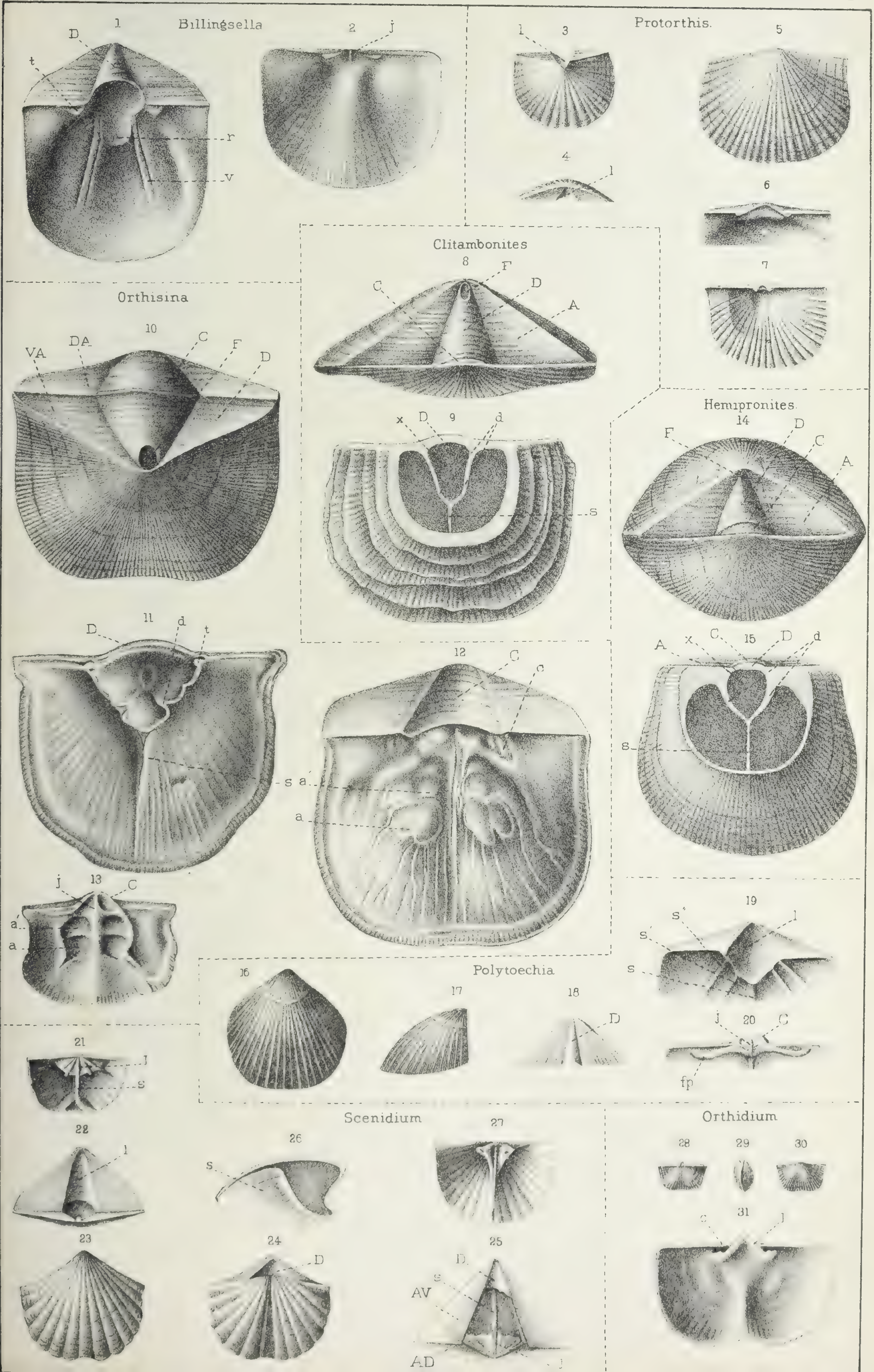
Fig. 19. The interior of the cardinal portion of the pedicle-valve. The deltidium has been removed, exposing the concave spondylium supported by median and lateral septa. × 3.

Fig. 20. The cardinal portion of the brachial valve; showing in profile the lateral portions of the chilidium partially inclosing the simple cardinal process. The socket walls are very divergent and nearly parallel to the hinge-line. × 3.

Calciferous beds. *Fort Cassin, Vermont.*

BRACHIOPODA.

Generic Illustrations.



SCENIDIUM, Hall.

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Scenidium pyramidale, Hall.

Fig. 22. A cardinal view of the pedicle-valve, showing the spondylium.
Niagara group. *Lockport, N. Y.*

Scenidium insigne, Hall.

Fig. 21. The interior of the brachial valve; showing the elevated hinge-plate and the prominent median septum. × 8.

Figs. 23, 24. Dorsal and ventral views of conjoined valves; showing the character of the exterior. × 8.

Fig. 25. A cardinal view of conjoined valves; showing the concave plate in the delthyrium (p), the hinge-plate (A) and the median septum (S). × 8.

Scenidium areola, Quenstedt.

Fig. 26. A longitudinal section of the two valves; showing the extension of the median septum into the cavity of the pedicle-valve. (Davidson.)

Scenidium Halli, Safford.

Fig. 27. The interior of a brachial valve; showing the triangular hinge-plate resting on the bottom of the valve, and the low median septum extending beyond the middle of the shell. × 4.
Trenton limestone. *Nashville, Tennessee.*

ORTHIDIUM, Hall.

Page 276.

Orthidium gemmicula, Billings.

Figs. 28, 29, 30. Three views of this shell. (After Billings.)

Fig. 31. The interior of a brachial valve; showing the simple, erect cardinal process, coalesced with the crural plates. × 4.
"*Point Lévis; in the upper part of the Limestone No. 2, Quebec group.*" (Billings.)

PLATE 9.

Legend. △. Deltidium.
t. Teeth.
j. Cardinal process.
fp. Crural plates.
a. Anterior adductor impressions.
a′. Posterior adductor impressions.
r. Anterior diductor impressions.
r′. Posterior diductor impressions.
v. Vascular markings
s′. Deltidial plate or callosity.
o. Ovarian markings.

ORTHIS, Dalman.

Pages 264, 265.

Orthis Davidsoni, de Verneuil.

Fig. 1. Interior of a pedicle-valve; showing the character of the cardinal and muscular areas.

Fig. 2. Profile of an individual having the valves in conjunction.

Fig. 3. A portion of the cardinal area of the brachial valve; showing the linear cardinal process, crural plates, thickened deltidial area and the low median ridge. × 3.

Upper Silurian limestone. *Island of Gotland.*

Orthis tricenaria, Conrad.

Figs. 4, 5. Dorsal and ventral views of a specimen with valves conjoined; showing the general exterior characters of this type of structure.

Fig. 6. The cardinal area of a pedicle-valve; showing the character of the apical callosity partially filling the delthyrium. × 3.

Trenton horizon. *St. Paul, Minnesota.*

Fig. 7. The interior of a brachial valve: showing the character of the cardinal process, crural plates and muscular area.

PLECTORTHIS, Hall.

Page 266.

Orthis plicatella, Hall.

Fig. 8. The cardinal portion of the brachial valve, showing the cardinal process, crural plates and low median ridge. × 3.

Fig. 9. A similar portion of the pedicle-valve; showing the broad delthyrium, teeth and muscular area. × 3.

Fig. 10. Dorsal view of a normal adult, a strongly biconvex shell with a moderately low cardinal area and strong, distant, simple ribs.

Hudson River group. *Covington, Kentucky.*

Generic Illustrations.

Orthis.

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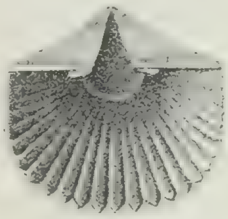

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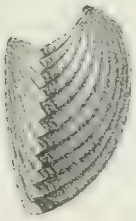

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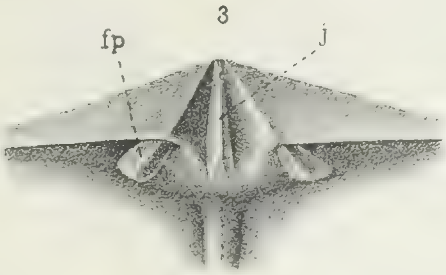

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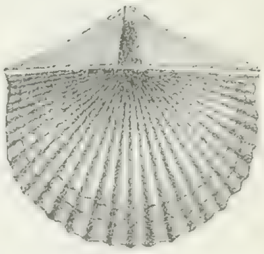

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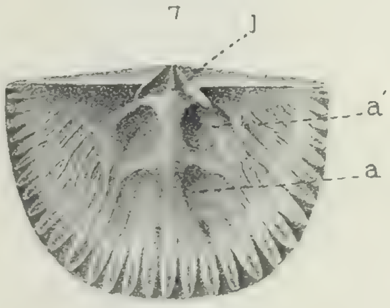

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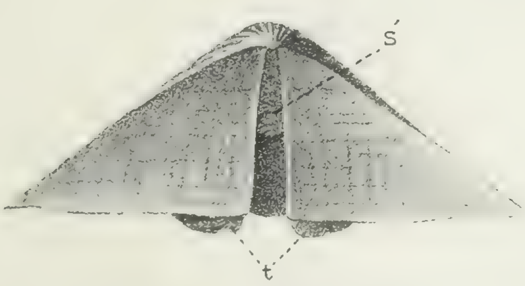

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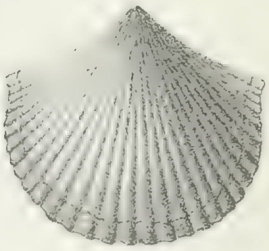

Plectorthis

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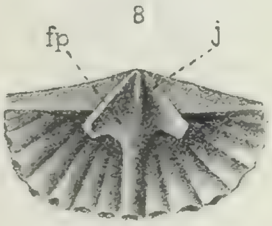

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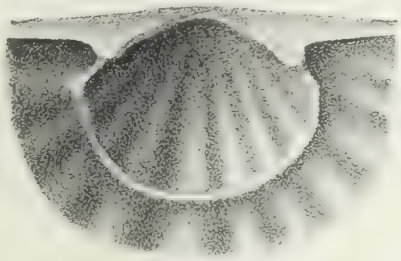

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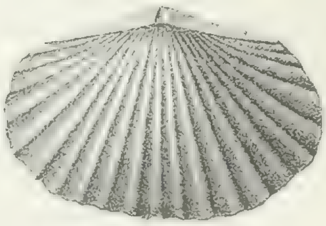

Dinorthis.

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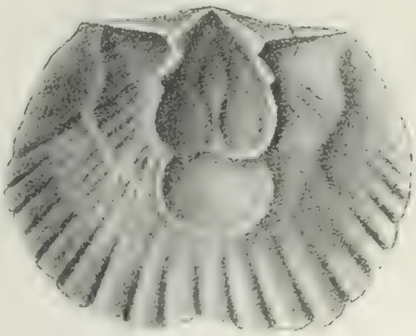

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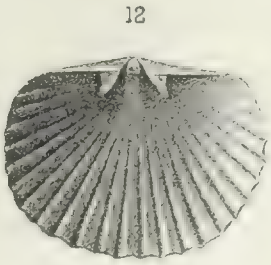

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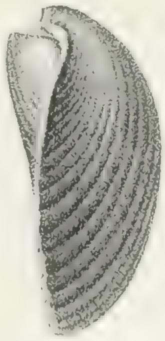

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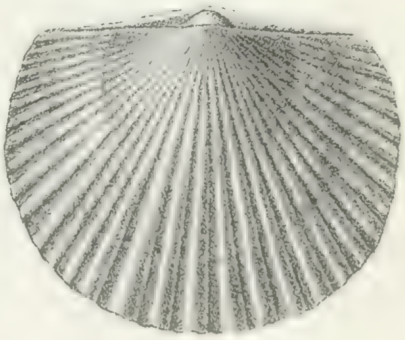

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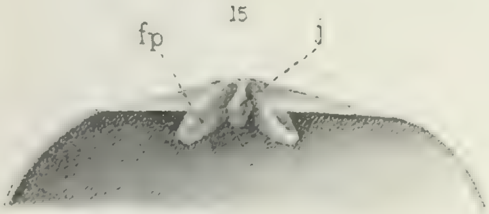
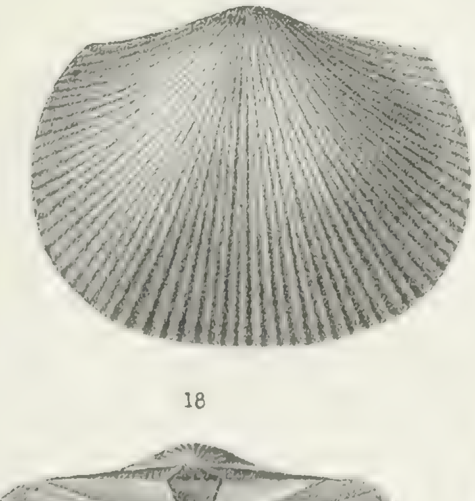


Plaesiomys.

16



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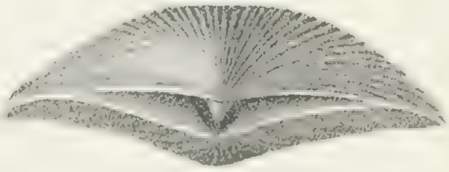

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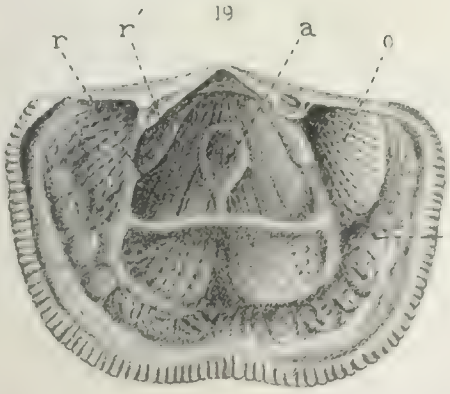

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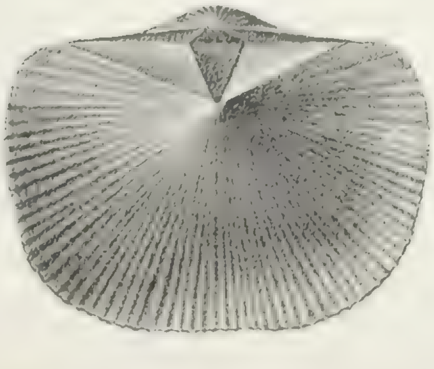

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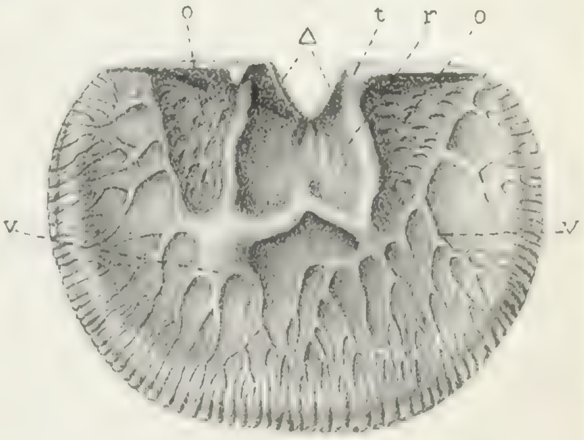

DINORTHIS, Hall.

Page 266.

Orthis pectinella (Emmons), Conrad.

Fig. 11. The interior of a pedicle-valve.

Fig. 13. A profile of conjoined valves; showing the reversed convexity.

Fig. 14. A ventral view of the same specimen.

Fig. 15. The cardinal portion of the brachial valve. × 3.
Trenton horizon. *Curdsville, Kentucky.*

Orthis Sweeneyi, N. H. Winchell.

Fig. 12. The interior of the brachial valve.
Trenton horizon. *St. Paul, Minnesota.*

PLÆSIOMYS, Hall.

Page 266.

Orthis subquadrata, Hall.

Figs. 16, 17. Brachial and cardinal views of a normal individual.

Fig. 19. The interior of the pedicle-valve; showing the component scars of the subquadrate muscular area, the lateral ovarian areas and the vascular impressions over the pallial region.
Hudson River group. *Oxford, Ohio.*

Orthis retrorsa, Salter (= *O. Carleyi*, Hall).

Fig. 18. A ventral view of the original specimen; showing the high area and retrorse beak of the pedicle-valve.

Fig. 20. The interior of a pedicle-valve; showing the short dental lamellæ, subquadrate muscular area, the vascular and ovarian markings.
Hudson River group. *Oxford, Ohio.*

PLATE 10.

Legend. △. Deltidium.
j. Cardinal process.
fp. Crural plates.
t. Teeth.
b. Sockets.
a. Anterior adductor impressions.
a′. Posterior adductor impressions.
r. Diductor muscular impressions.
p. Pedicle-muscular impression.
o. Ovarian impressions.
v. Vascular markings.

HEBERTELLA, Hall.

Page 266.

Orthis sinuata, Hall.

Fig. 1. Dorsal view of a normal example.

Fig. 2. Profile view of the same specimen.

Fig. 3. The interior of a brachial valve.

Fig. 4. The interior of a pedicle-valve ; giving the character of the muscular area, ovarian and vascular markings.

Hudson River group. *Cincinnati, Ohio.*

ORTHOSTROPHIA, Hall.

Page 267.

Orthis strophomenoides, Hall.

Fig. 5. The exterior of a brachial valve.

Fig. 6. A cardinal view of the same specimen.

Fig. 7. An internal cast of the brachial valve, retaining the impression of the simple cardinal process and showing the four sharply defined adductor scars, the ovarian markings and the ramified vascular sinuses.

Fig. 8. An internal cast of the pedicle-valve ; showing the very small muscular area, the ovarian markings in the umbo-lateral regions, and the vascular sinuses over the pallial region.

Lower Helderberg group. *Near Clarksville, N. Y.*

PLATYSTROPHIA, King.

Page 268.

Orthis biforata, Schlotheim, var. lynx, von Eichwald.

Fig. 9. The interior of a brachial valve, showing the narrow, linear, cardinal process, large crural plates and the quadripartite impression of the adductor muscles.

Fig. 10. A cardinal view of an average individual ; showing the area and delthyrium of each valve.

BRACHIOPODA.

Generic Illustrations.

Hebertella

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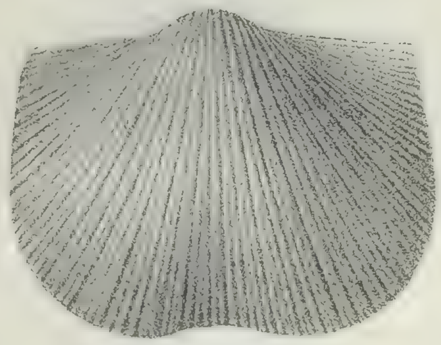

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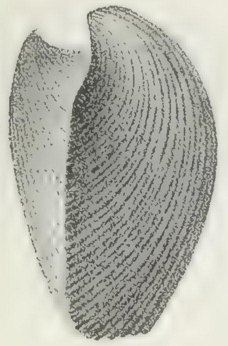

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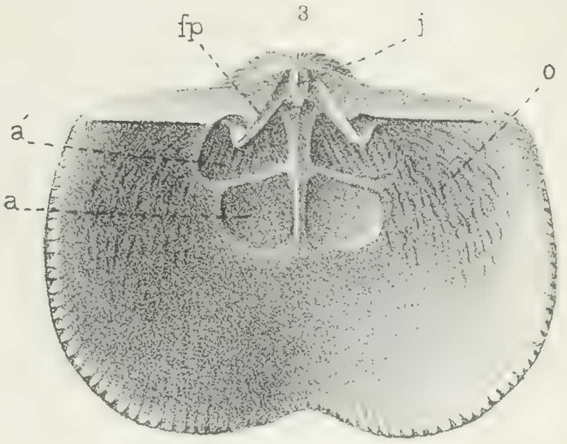

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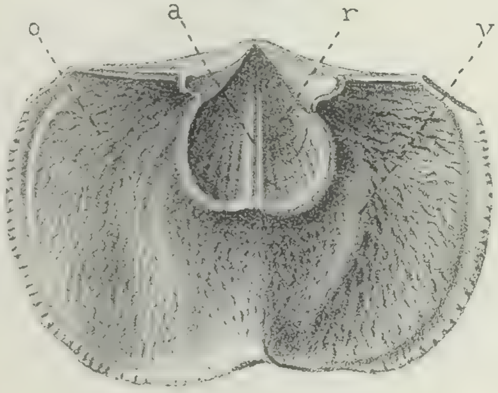

Orthostrophia

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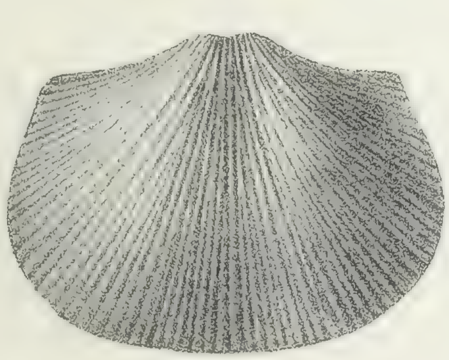

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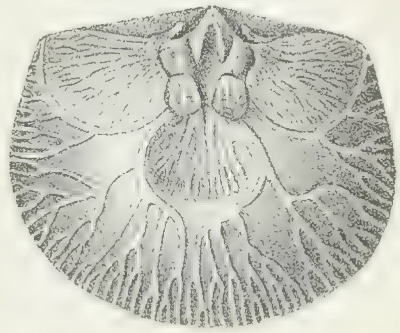

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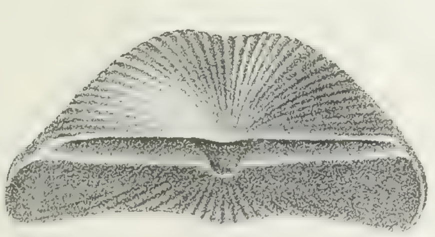

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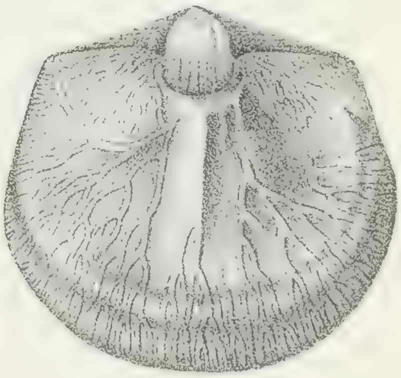

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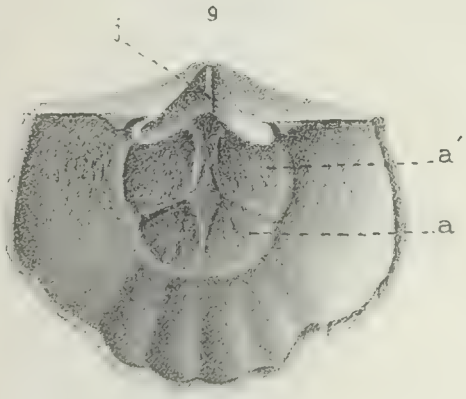

Platystrophia

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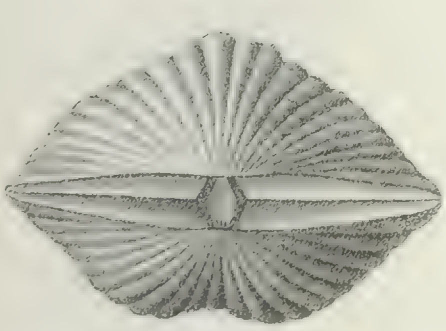

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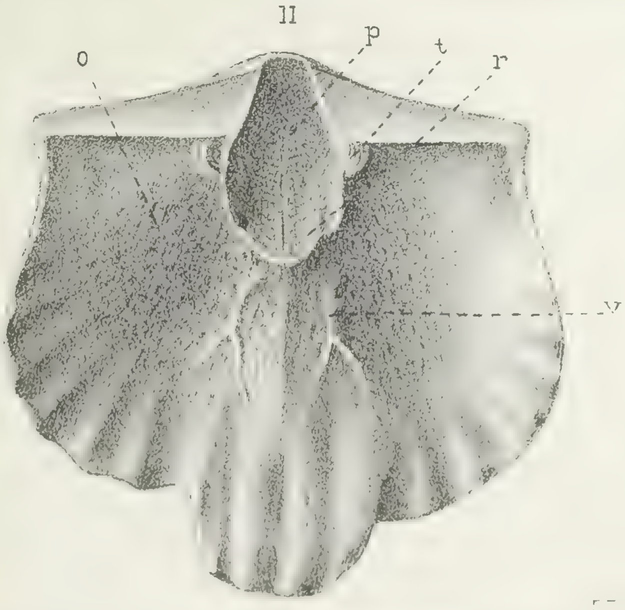

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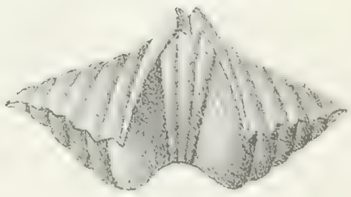

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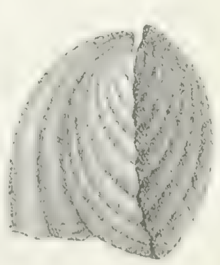

Bilobites

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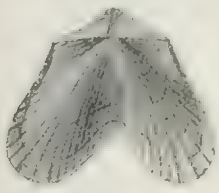

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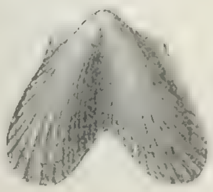

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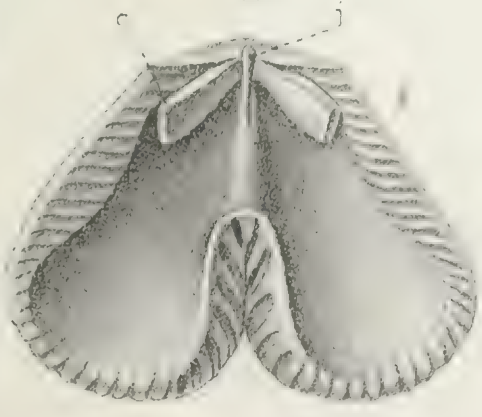

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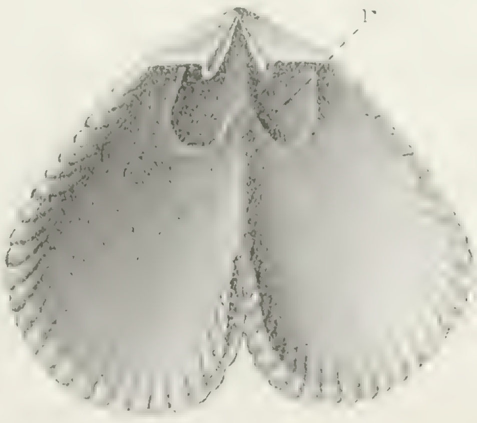

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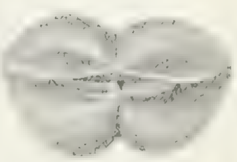

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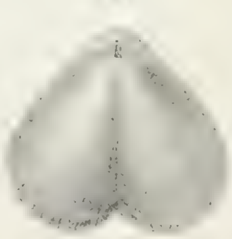

Fig. 11. The interior of a large pedicle-valve. The apical portion of the shell has been absorbed, this being the usual condition in old shells, thus exposing the impression of the pedicle-muscle. The specimen also shows the compact form of the muscular scars, the vascular trunks and ovarian markings.

Hudson River group. *Cincinnati, Ohio.*

ORTHIS BIFORATA, Schlotheim, var. LATICOSTA, Meek.

Figs. 12, 13. Front and profile views; showing the high median fold characterizing this form.

Hudson River group. *Cincinnati, Ohio.*

BILOBITES, LINNÉ.

Page 269.

ORTHIS BILOBA, Linné.

Figs. 14, 15. Dorsal and ventral views of an average example. × 3.

Niagara group. *Lockport, N. Y.*

ORTHIS VARICA, Conrad.

Figs. 16, 17. Cardinal and dorsal views of the same specimen. × 2.

Fig. 18. The interior of the brachial valve; showing the cardinal process, the great crura, large muscular area, and the pectinated surfaces of marginal contact. × 5.

Fig. 19. The interior of the pedicle-valve; showing the area, delthyrium, teeth and outline of the muscular area. × 4.

Lower Helderberg group. *Near Clarksville, N. Y.*

1891 42 197

PLATE 11.

Legend. △. Deltidium.
t. Teeth.
b. Sockets.
fp. Crural plates.
j. Cardinal process.
c. Crura.
a. Anterior adductor scars.
a′. Posterior adductor scars.
r. Diductor scars.
o. Ovarian markings.
v. Vascular markings.

HETERORTHIS, Hall.

Page 268.

ORTHIS CLYTIE, Hall.

Fig. 1. A dorsal view of the original specimen; showing cardinal area and foramen, and leptænoid exterior.

Fig. 2. The interior of a pedicle-valve; showing the elongate scars of the diductor muscles and the small adductor impressions.

Fig. 3. The interior of a brachial valve; showing the simple cardinal process and the elevated socket walls. Muscular area small and obscurely quadripartite.

Trenton horizon. *Near Frankfort, Kentucky.*

DALMANELLA, Hall.

Page 270.

ORTHIS TESTUDINARIA, Dalman.

Fig. 4. The interior of a pedicle-valve.

Fig. 5. The interior of a brachial valve.

Trenton horizon. *Mineral Point, Wisconsin.*

Fig. 6. Ventral view of the exterior of an average specimen.

Fig. 7. Profile of a somewhat larger shell.

Fig. 11. The central cardinal portion of a brachial valve, enlarged to show the structure of the articulating apparatus.

Hudson River group. *Cincinnati, Ohio.*

Also in Trenton limestone and Hudson River group, State of New York.

ORTHIS SUBÆQUATA, Conrad.

Fig. 9. The interior of a brachial valve; showing the slender cardinal process, the socket walls and adductor scars.

Fig. 10. The interior of the pedicle-valve; showing the form of the muscular impression.

Trenton horizon. *Mineral Point, Wisconsin.*

BRACHIOPODA.

Generic Illustrations.

Heterorthis.

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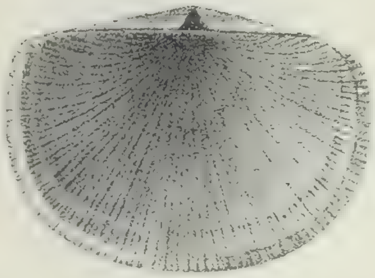

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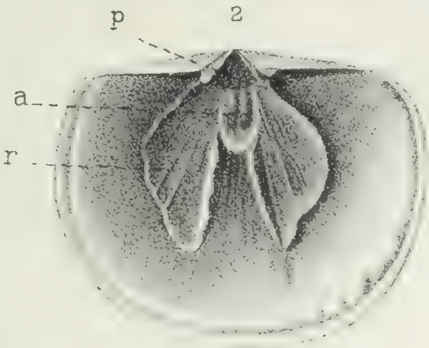

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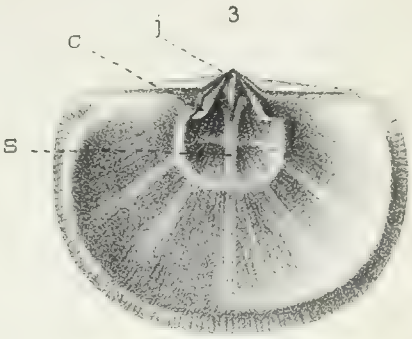

Dalmanella.

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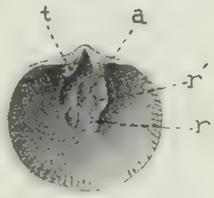

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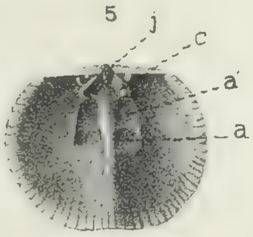

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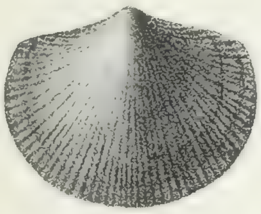

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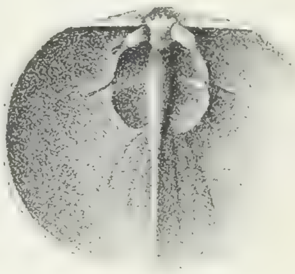

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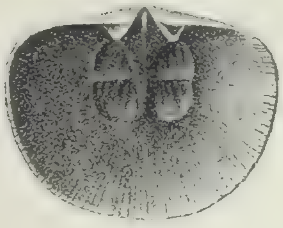

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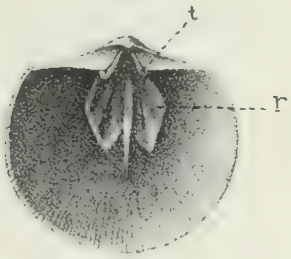

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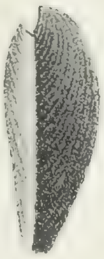

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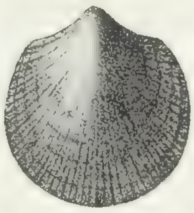

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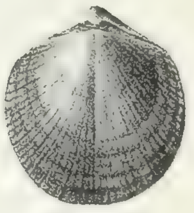

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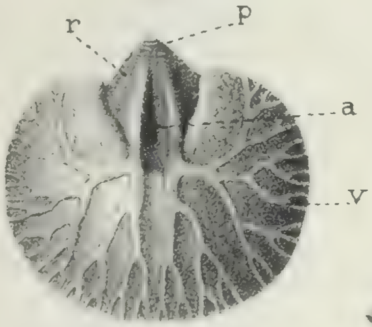

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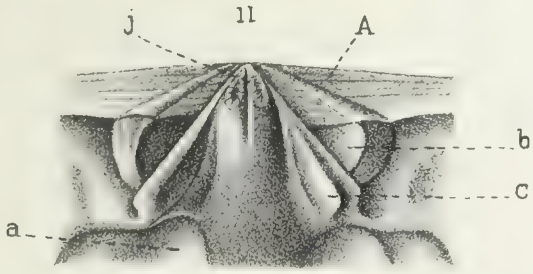

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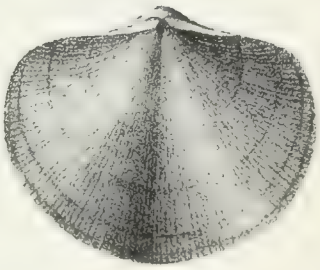

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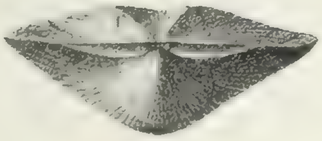

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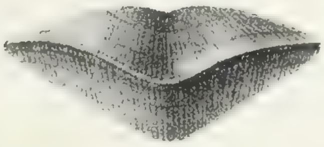

Schizophoria.

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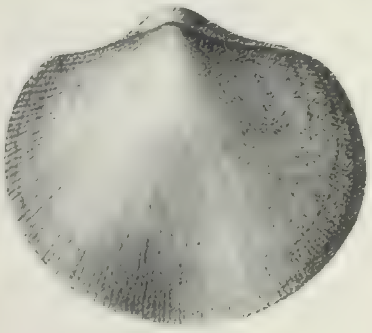

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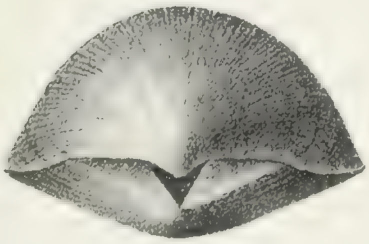

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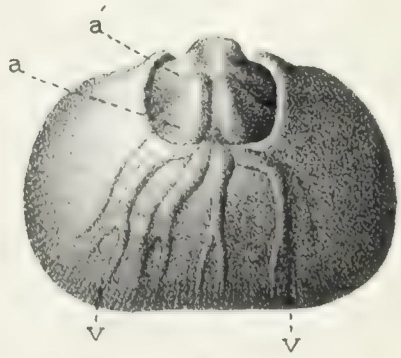

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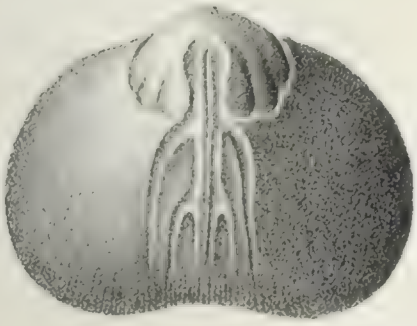

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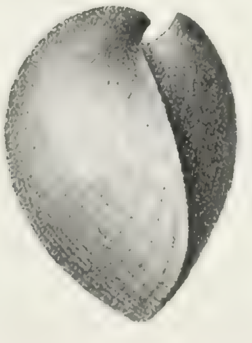

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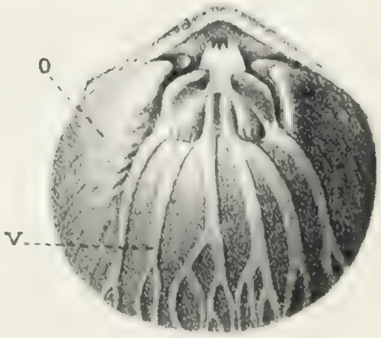

ORTHIS ELEGANTULA, Dalman.

Figs. 12, 13. Ventral and dorsal views of the same individual; showing the form of the species as occurring at this locality.

Niagara group. *Waldron, Indiana.*

ORTHIS SUBCARINATA, Hall.

Fig. 8. The interior of a brachial valve.

Fig 14. A natural internal cast of the opposite valve, preserving the ramifications of the vascular sinuses, and showing also the ovarian spaces and muscular scars.

Figs. 15, 16, 17. Dorsal, cardinal and front views of the exterior of a normal individual; showing its form and contour.

Lower Helderberg group. *Near Clarksville, N. Y.*

SCHIZOPHORIA, KING.

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ORTHIS TULLIENSIS, Hall.

Figs. 18, 19, 20. Three views of a normal individual; showing the great convexity of the brachial valve and the shallow pedicle-valve.

Tully limestone. *Keuka Lake, N. Y.*

ORTHIS PROPINQUA, Hall.

Fig. 21. An internal cast of the brachial valve. The subdivision and the course of the vascular sinuses are sharply retained.

Corniferous limestone. *Avon, N. Y.*

ORTHIS IMPRESSA, Hall.

Fig. 22. An internal cast of the pedicle-valve; showing the subdivisions of the muscular area, and the unusual arrangement of the vascular sinuses.

Fig. 23. An internal cast of the brachial valve; showing some difference in the number and arrangement of the vascular trunks.

Chemung group. *Lawrenceville, Pennsylvania.*

PLATE 12.

Legend. A. Cardinal area.
t. Teeth.
b′. Sockets.
d. Dental lamellæ.
c. Crura.
s. Median septum.
j. Cardinal process.

p. Pedicle-area.
a. Anterior adductor scars.
a′. Posterior adductor scars.
r. Anterior diductor scars.
r′. Posterior diductor scars.
v. Vascular markings.
o. Ovarian markings.

RHIPIDOMELLA, ŒHLERT.

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ORTHIS HYBRIDA, Sowerby.

Figs. 1, 2. Two views of an average individual of the American form referred to this species.

Fig. 3. The interior of the pedicle-valve: showing the expanded muscular scars.

Niagara group. *Lockport, N. Y.*

ORTHIS VANUXEMI, Hall.

Fig. 4. The interior of a brachial valve, retaining with unusual distinctness the four scars of the adductor muscles. The ridges radiating from the anterior margin of the muscular area, are probably of vascular origin.

Hamilton group. *Canandaigua Lake, N. Y.*

Fig. 9. An internal cast of the pedicle-valve: showing the scar of the pedicle, diductor and adductor muscles.

Hamilton group. *Cumberland, Maryland.*

ORTHIS MICHELINI, L'Éveillé.

Fig. 5. A dorsal view of a specimen retaining the spines on a portion of its surface. (DAVIDSON.)

Fig. 6. The interior of the pedicle-valve. (DAVIDSON.)

Carboniferous limestone and shales. *Ayrshire, Scotland.*

ORTHIS PENELOPE, Hall.

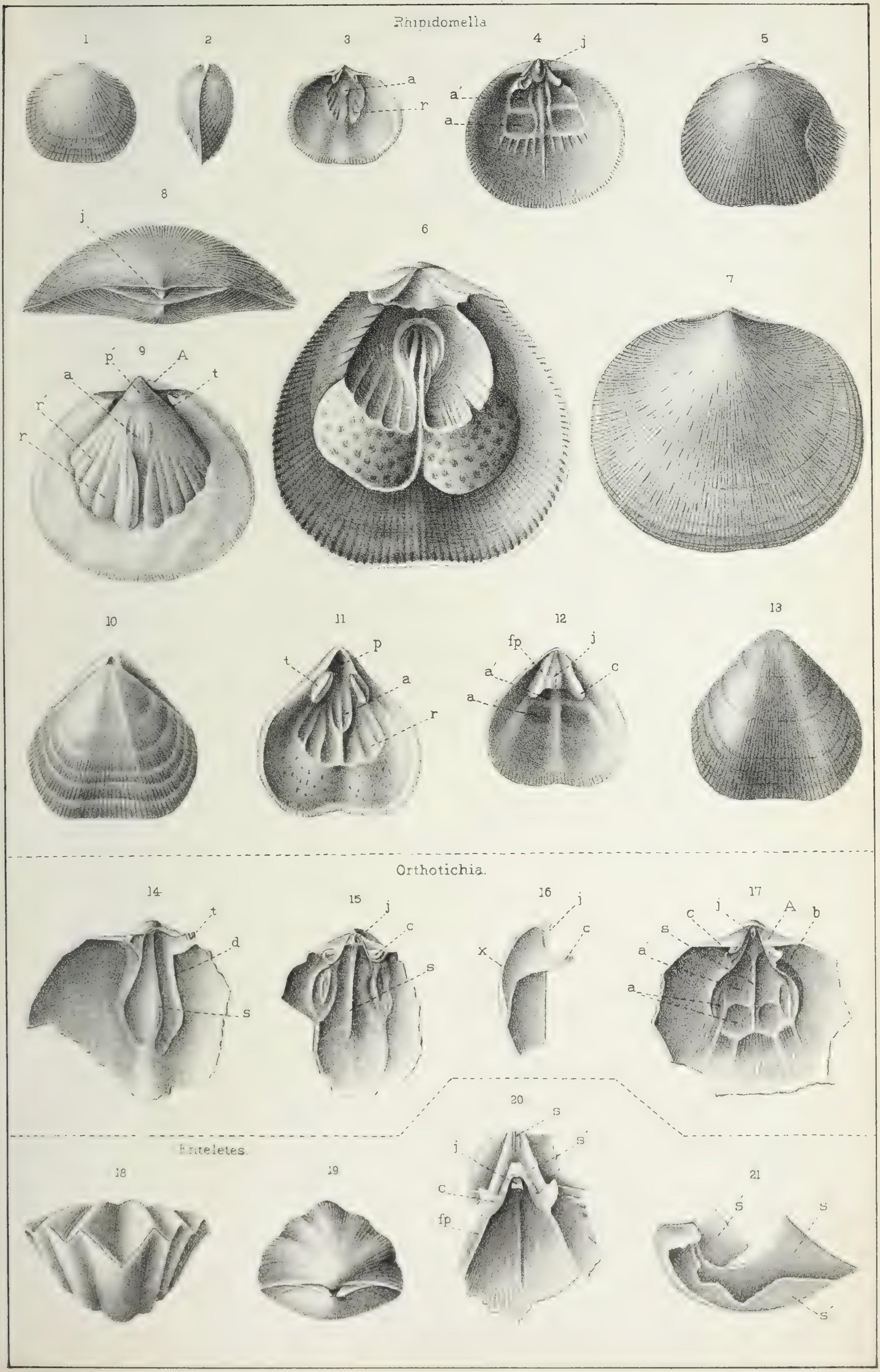
Figs. 7, 8. Ventral and cardinal views of a full-grown individual: showing the external characters.

Hamilton group. *Western New York.*

BRACHIOPODA.

Generic Illustrations.

Report State Geologist, 1891. Plate 12.



James B. Lyon, State Printer.

ORTHIS DUBIA, Hall.

Figs. 10, 13. Dorsal and ventral views of the exterior. × 2.
St. Louis group. *Lebanon, Kentucky.*

Fig. 11. The interior of the pedicle-valve; showing the division of the muscular area.
St. Louis group. *Litchfield, Kentucky.*

Fig. 12. The interior of the brachial valve; showing the cardinal process.
St. Louis group. *Lanesville, Indiana.*

ORTHOTICHIA, HALL.

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ORTHIS MORGANIANA, Derby.

Fig. 14. The interior of a portion of the pedicle-valve; showing the elevation of the teeth and the outline of the muscular area.

Fig. 15. The interior of the brachial valve.

Fig. 16. Section in profile of the brachial valve; showing the extent of the crural plates and the elevation of the crura.

Fig. 17. The interior of another pedicle-valve; showing the muscular area in fuller detail.
Coal Measures. *Itaitubá, Brazil.*

ENTELETES, FISCHER DE WALDHEIM.

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ENTELETES HEMIPLICATA, Hall.

Fig. 18. Frontal view of a mature individual; showing the characters of the exterior.
Coal Measures. *Winterset, Iowa.*

Fig. 19. A cardinal view of a younger shell.
Coal Measures. *Kansas City, Nebraska.*

Fig. 20. The interior of the rostral portion of the two valves in articulation. The median septum of the upper or pedicle-valve is broken off, but the lateral septa are retained. In the brachial valve are seen the high crural plates which are produced into strongly recurved crura. At (j) is the small lobate cardinal process, and in the bottom of the valve a low median ridge. × 2.

Fig. 21. A profile of the rostral portion of the pedicle-valve; showing the great elevation of the median and lateral septa, the edges of which are more or less broken. × 3.
Upper Coal Measures. *Winterset, Iowa.*

PLATE 13.

Legend. D. Deltidium.
C. Chilidium.
△. Delthyrium.
F. Foramen.
F′. Groove on chilidium.
A. Cardinal area.
  a. Inner portion.
  a′. Outer portion.
b. Dental sockets.
t. Teeth.
j. Cardinal process.
a. Adductor scars.
r. Anterior diductor scars.
r′. Posterior diductor scars.
c. Socket walls.

LEPTÆNA, DALMAN.

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LEPTÆNA TENUISTRIATA, Sowerby (= *L. rhomboidalis*, Wilckens).

Figs. 1, 2. Views of opposite sides of an individual in which the foramen is retained.

Hudson River group. *Oxford, Ohio.*

LEPTÆNA RHOMBOIDALIS, Wilckens.

Fig. 3. An enlargement of the beaks of an old individual; showing the great obliquity of the foramen in the pedicle-valve, which penetrates the substance of the shell at a considerable distance in advance of the apex; and also the groove in the chilidium of the opposite valve.

Fig. 4. An enlargement of the articulating apparatus of the brachial valve; showing the central groove of the chilidium, the lobes of the cardinal process and the dental sockets with their low, thick inner walls (crural plates). × 3.

Niagara group. *Waldron, Indiana.*

Fig. 6. The interior of a brachial valve; showing the aspect of the cardinal process from this point of view, the character of the muscular scars, and the strong ridge at the line of geniculation of the valve.

Fig. 7. The interior of a pedicle-valve; showing the character of the muscular impressions.

Lower Helderberg group. *Albany and Schoharie counties, N. Y.*

Fig. 8. The exterior of a pedicle-valve, in which the undulations are finer and much more numerous than usual. (The *L. undulata* of VANUXEM.)

Corniferous limestone. *Western New York.*

Fig. 9. The interior of a brachial valve.

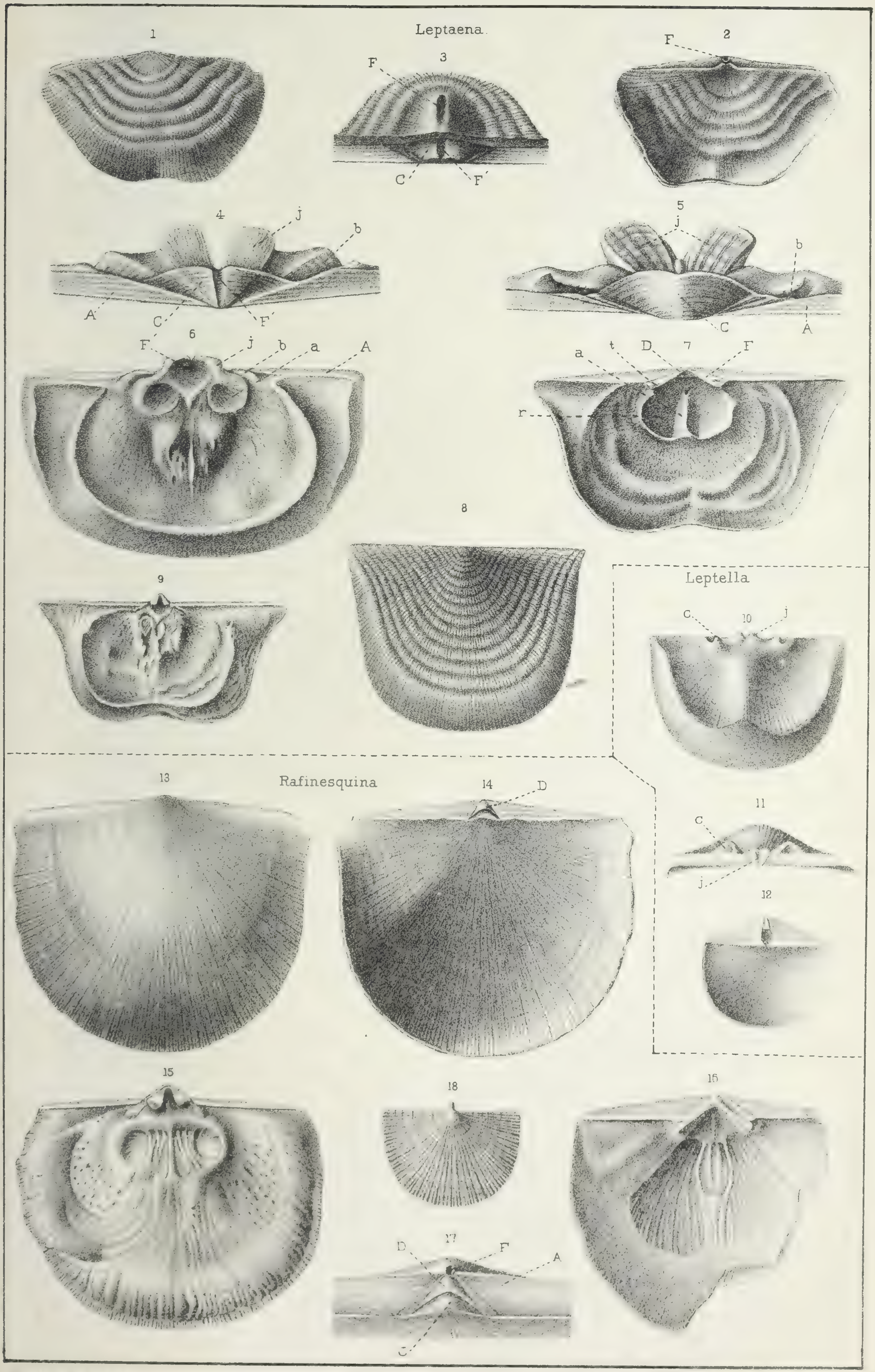
Waverly group. *Mallets' Creek, Ohio.*

BRACHIOPODA.

Generic Illustrations.

Report State Geologist, 1891.

Plate 13.



LEPTELLA, HALL.

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LEPTELLA SORDIDA, Billings (sp.).

Fig. 10. The interior of a brachial valve. The cardinal process consists of two independent apophyses, not coalesced with the crural plates, the latter being depressed at their origin but considerably elevated at their extremities. The visceral region is concave on either side of a broad median ridge and its surface radially striated; from its anterior margin the surface of the valve is abruptly and evenly deflected. × 5.

Fig. 11. Cardinal view of the same specimen; showing the width of the area, the posterior face of the cardinal process and the elevation of the crural plates. × 5.

Fig. 12. Dorsal views of a specimen retaining both valves, and showing the outline, contour and general external characters of the species. The delthyrium of the pedicle-valve is partially closed by a convex deltidium. × 3.

These figures are from the original specimens of the species.

"*Point Lévis; in the upper part of the Limestone No. 2, Quebec group.*" (BILLINGS.)

RAFINESQUINA, HALL.

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RAFINESQUINA ALTERNATA, Conrad.

Fig. 5. A posterior view of the articulating apparatus of the brachial valve. The incisor-shaped branches of the cardinal process are widely divergent, and at the bottom of the bifurcation lies a narrow callosity. The deltidium is well developed but not grooved in the middle, and the dental sockets are deeply marked. × 3.

Figs. 13, 14. Two views of a specimen presenting normal external characters.

Fig. 15. The interior of a brachial valve, with sharply-defined anterior and posterior adductor scars, and showing faint traces of recurving vascular sinuses.

Fig. 16. The interior of a pedicle-valve, in which the muscular scars have their normal character.

Fig. 17. An enlargement of a portion of the hinge area, showing the deltidium and chilidium and the retention of the foramen at maturity. × 3.

Hudson River group. *Cincinnati, Ohio.*

RAFINESQUINA ULRICHI, James.

Fig. 18. The exterior of a mature pedicle-valve in which the primitive condition of the pedicle passage as a tube or sheath is retained. This appears to be a normal feature of maturity in this species. × 2.

Hudson River group. *Covington, Kentucky.*

PLATE 14.

Legend. D. Deltidium.
△. Delthyrium.
j. Cardinal process.
s. septum.
b. Dental sockets.
r. r′. Diductor scars.
a. Anterior adductors.
a′. Posterior adductors.
o. Ovarian spaces.
v. Vascular sinuses.

GENUS STOPHEODONTA, HALL.

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STOPHEODONTA DEMISSA, Conrad.

Fig. 1. A dorsal view of a large individual; showing no evidence of deltidium on the striated cardinal area of the pedicle-valve.

Fig. 2. A profile view of the same.

Fig. 3. The interior of a pedicle-valve; showing the muscular impressions. The center of the area has been broken away by the detachment of the cardinal process.

Fig. 4. An enlargement of the cardinal areas; showing the vertical striæ and complete obsolescence of the deltidia. × 2½.

Hamilton group. *Western New York.*

STROPHEODONTA CONCAVA, Hall.

Fig. 5. The central cardinal portion of the brachial valve of a mature individual. The lobes of the cardinal process are of great size and deeply grooved, the crural plates in a rudimentary condition and the muscular scars much thickened. × 2.

Fig. 6. A posterior view of the same specimen; showing the crenulated edges of the lobes of the cardinal process and the size of the crural plates. At x the base of the cardinal process has been excavated for the reception of the margin of the pedicle-valve. × 2.

Hamilton group. *Canandaigua Lake, N. Y.*

BRACHYPRION, SHALER.

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BRACHYPRION PROFUNDUS, Hall.

Fig. 7. The interior of a pedicle-valve having the delthyrium but partially closed, and showing the strong crenulations of the cardinal margin near the delthyrium.

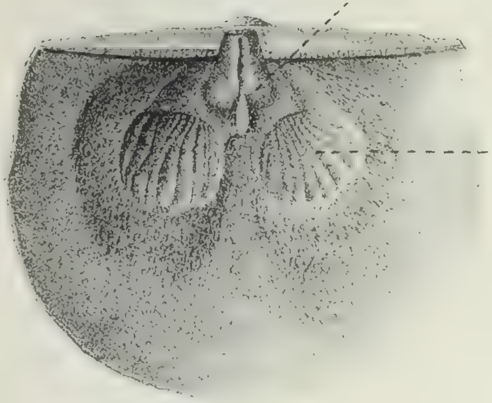
Niagara group. *Waldron, Indiana.*

BRACHIOPODA.

Generic Illustrations.

Stropheodonta.

3



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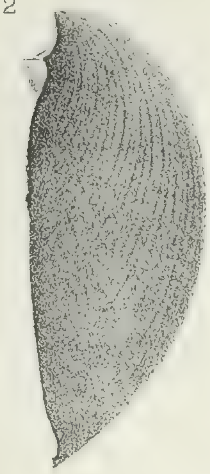

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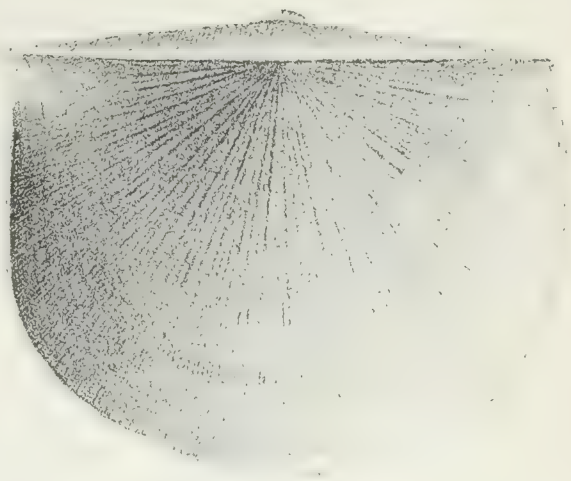

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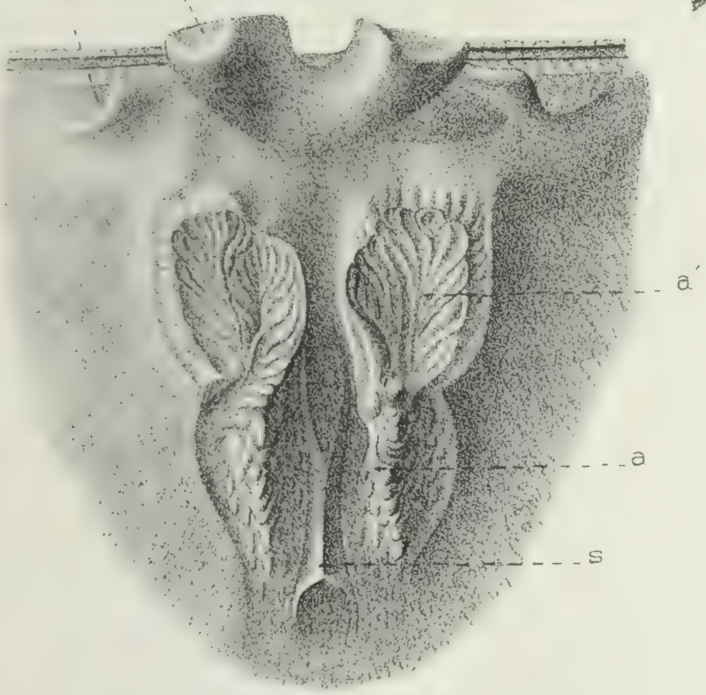

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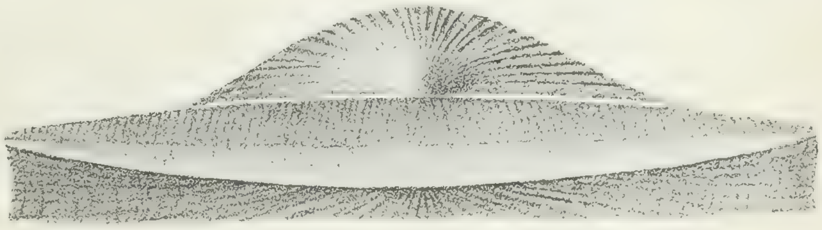

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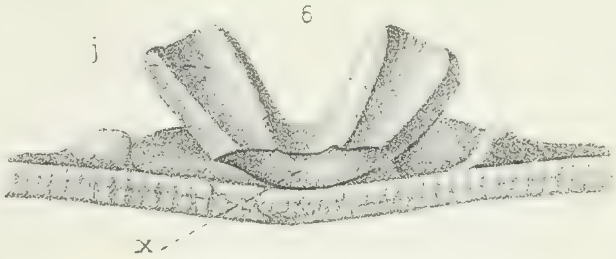

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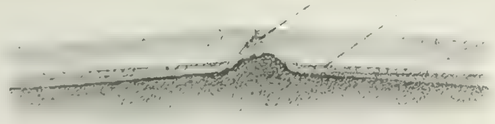

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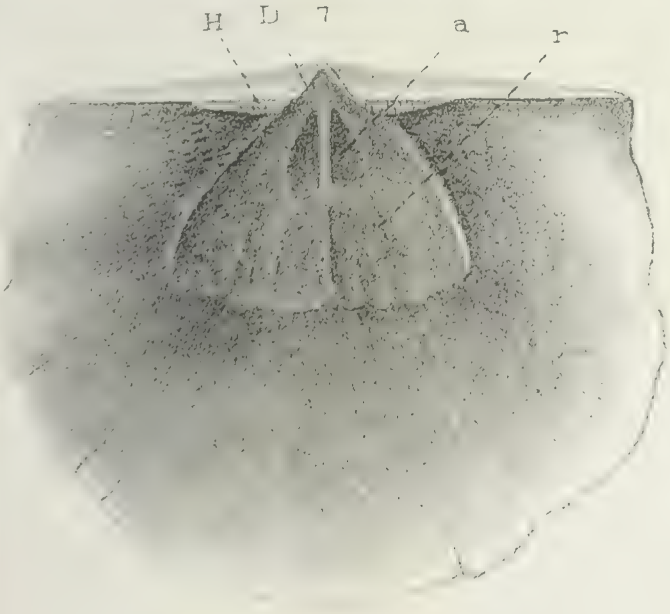

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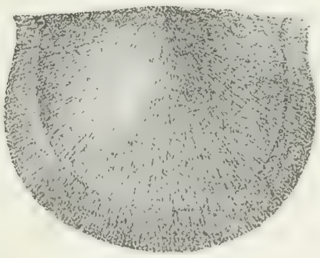

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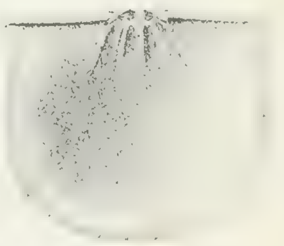

Pholidostrophia

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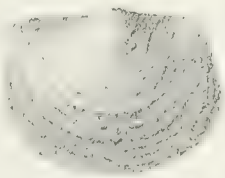

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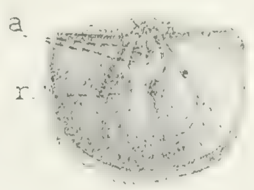

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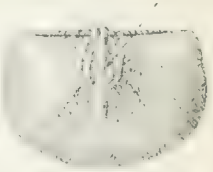

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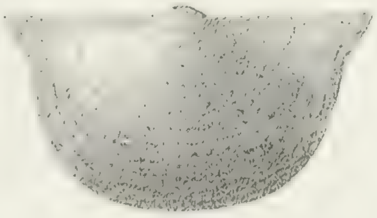

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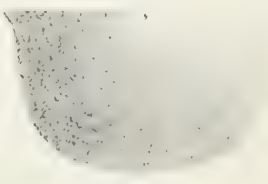

Douvillina

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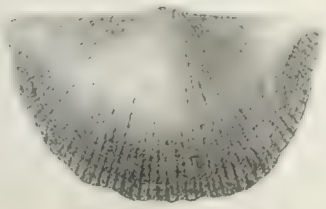

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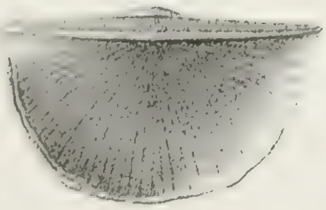

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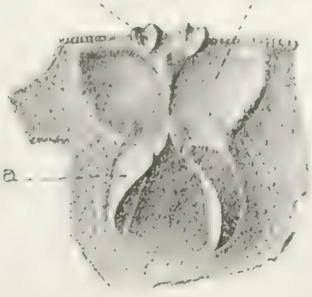

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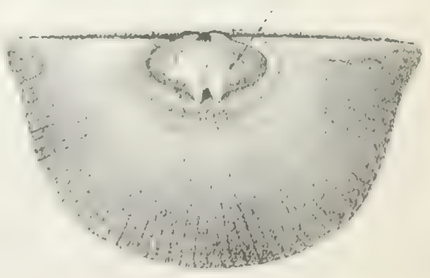

BRACHYPRION VARISTRIATUS, Conrad.

Fig. 8. An enlargement of the central part of the cardinal area; showing the character of the deltidium and the short row of crenulations. × 3.

Fig. 9. The exterior of the pedicle-valve.

Fig. 10. The interior of a similar valve.

Lower Helderberg group (Tentaculite and Pentamerus limestones). *Schoharie Co., N. Y.*

PHOLIDOSTROPHIA, HALL.

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PHOLIDOSTROPHIA NACREA, Hall.

Fig. 11. The exterior of the pedicle-valve; showing the squamous, unplicated exterior.

Fig. 12. The interior of the pedicle-valve; showing the muscular impressions and partially closed delthyrium.

Fig. 13. The interior of a brachial valve; showing the crenulated hinge-margin, cardinal process and muscular impressions.

Hamilton group. *Western New York.*

PHOLIDOSTROPHIA LINDAHLI, sp. nov.

Figs. 14, 15. The exterior of the pedicle and brachial valves.

Corniferous limestone. *Illinois.*

DOUVILLINA, ŒHLERT.

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DOUVILLINA INÆQUISTRIATA, Hall.

Figs. 16, 17. Two views, giving the external characters of the species.

Fig. 18. The central portion of the interior of the brachial valve, enlarged to show the broad, flat posterior muscular scars and the elevated anterior muscular ridges. × 3.

Hamilton group. *Western New York.*

DOUVILLINA CAYUTA, Hall.

Fig. 19. An internal cast of the pedicle-valve; showing the short, transverse, sharply defined muscular scar.

Chemung group. *Steuben county, N. Y.*

PLATE 15.

Legend. H. Hinge-line.
D. Deltidium.
t. Teeth.
b. Dental sockets.
s. Median septum.
d. Brachial valve.
v. Pedicle-valve.
j. Cardinal process.
a. Anterior adductors.
a′. Posterior adductors.
r. Anterior diductors.
r′. Posterior diductors.
C. Chilidium.

LEPTOSTROPHIA, Hall.

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Leptostrophia perplana, Conrad.

Fig. 1. The exterior of the pedicle-valve of an average specimen.
Hamilton group. *Western New York.*

Fig. 2. An enlargement of the interior umbonal portion of the brachial valve; showing the cardinal process and lateral muscular ridges. × 2.
Hamilton group. *Canandaigua Lake, N. Y.*

Fig. 3. A longitudinal axial section of the two valves; showing the normal curvature of the shell and the position of the cardinal process.
Hamilton group. *Western New York.*

Leptostrophia magnifica, Hall.

Fig. 4. The interior of a pedicle-valve; showing the formation of a pedicle-pit in the delthyrium, by the union of the dental lamellæ; also the expanded, undefined muscular area.
Oriskany sandstone. *Cumberland, Maryland.*

STROPHONELLA, Hall.

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Strophonella semifasciata, Hall.

Fig. 5. The exterior of the concave pedicle-valve.

Fig. 6. An enlargement of the central portion of the cardinal areas of conjoined valves; showing the deltidium (D) and chilidium (C).
Niagara group. *Waldron, Indiana.*

Strophonella Leavenworthana, Hall.

Fig. 7. The interior of the brachial valve; showing the crenulation of the cardinal margin, the cardinal process, slightly developed crural plates and the adductor impressions.

Fig. 8. The interior of the pedicle-valve; showing the crenulation of the hinge-margin, the closed delthyrium and the arrangement of the muscular scars.

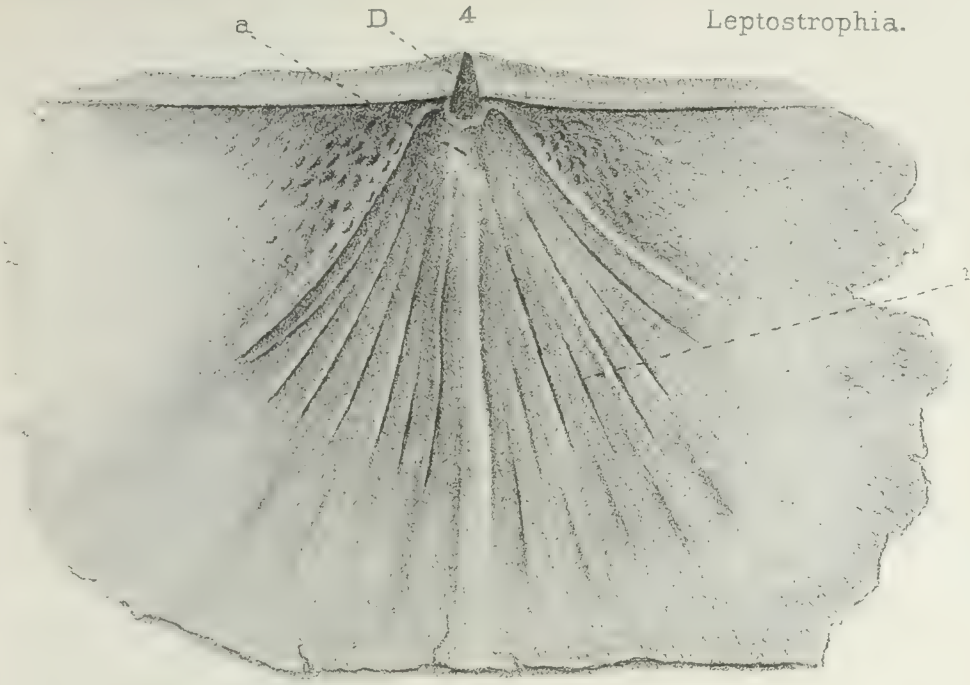
BRACHIOPODA.

Generic Illustrations.

Report State Geologist, 1891.

Plate 15.

Leptostrophia.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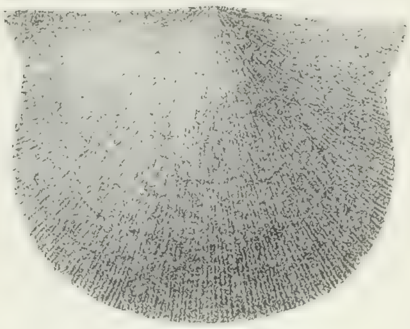
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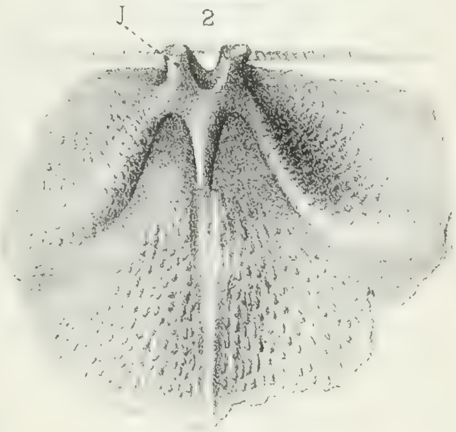
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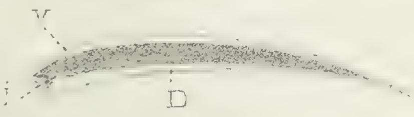
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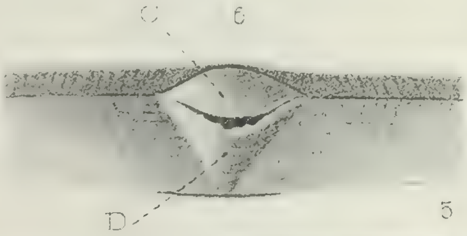
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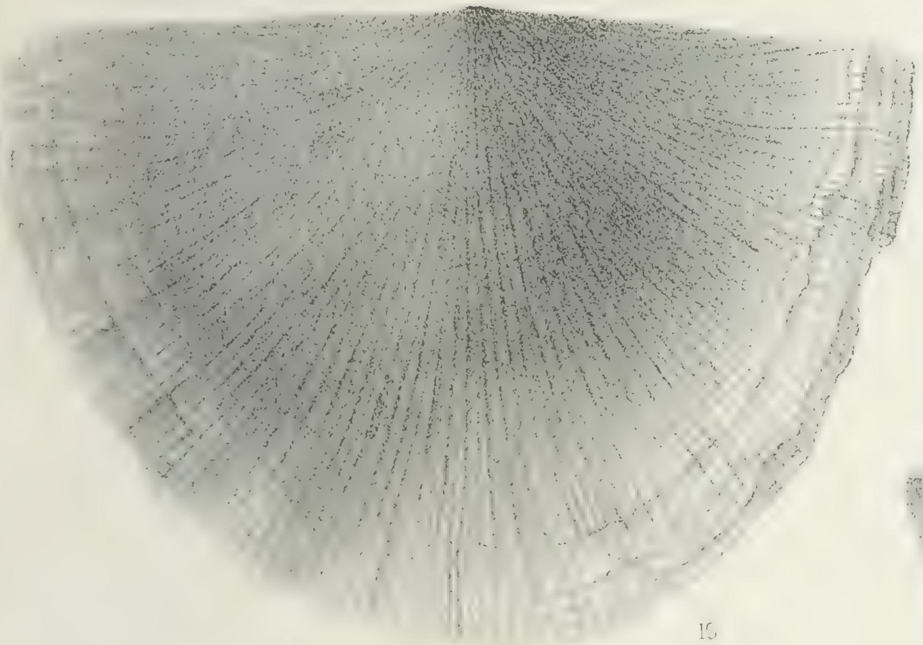
Strophonella.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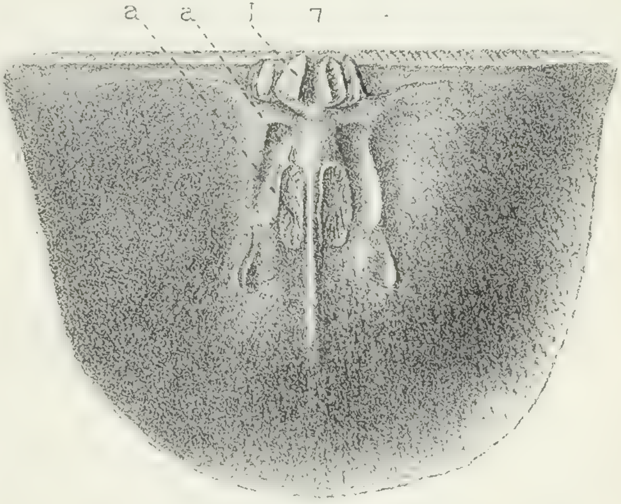
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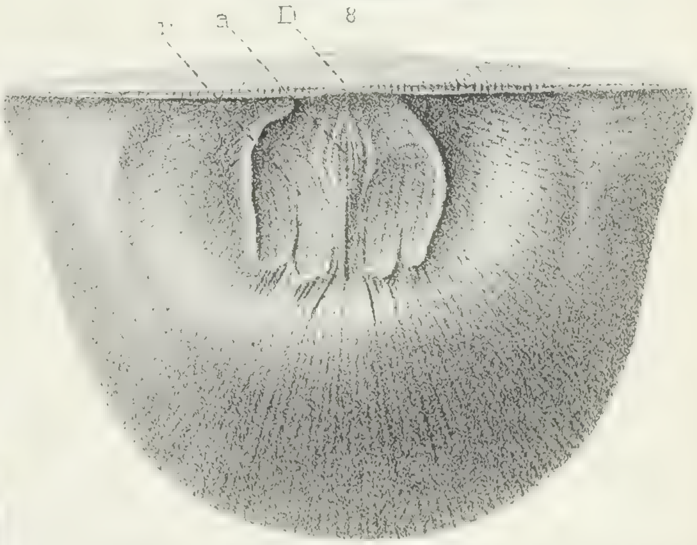
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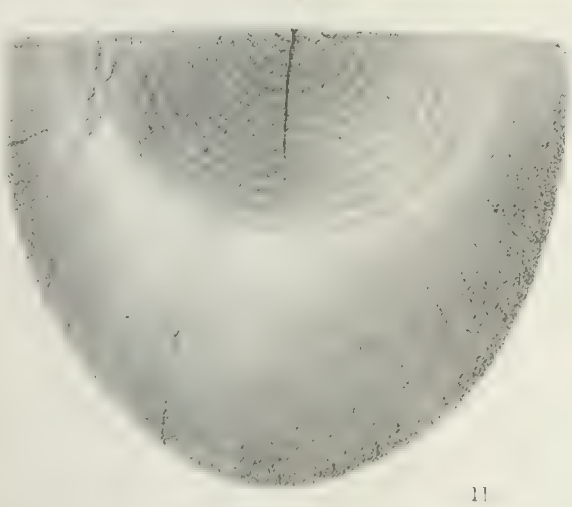
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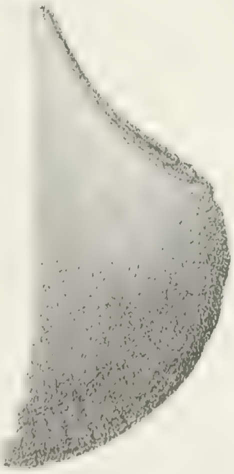
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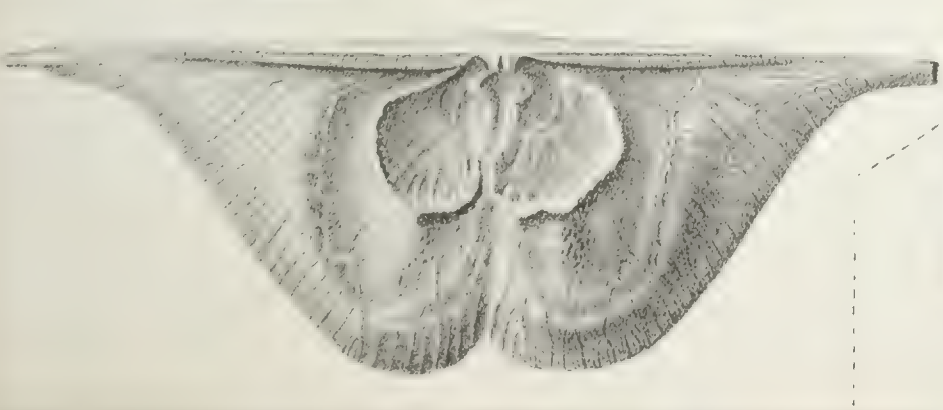
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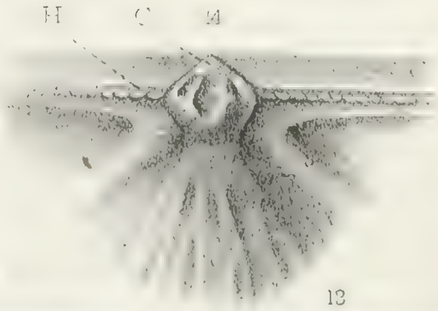
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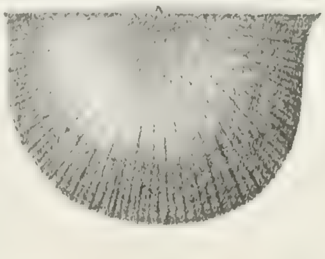
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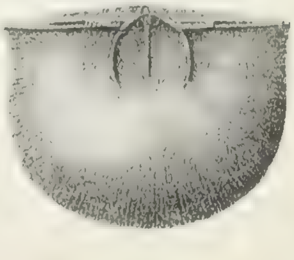
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Fig. 9. The exterior of a brachial valve.

Fig. 10. A profile of the same specimen; showing the concavity in early growth stages, followed by great convexity and strong geniculation.

Lower Helderberg group. *Albany county, N. Y.*

STROPHONELLA CÆLATA, Hall.

Fig. 11. The interior of a brachial valve in an unusually fine state of preservation. The flabellate muscular scars have the form usual to this genus and similar to that characterizing DOUVILLINA. The crenulations of the hinge-line do not extend to the extremities of the cardinal area; a feature of frequent occurrence in many of the earlier species of STROPHEODONTA. The impressions of the pallial sinuses are also distinctly shown.

Chemung group. *Near Addison, N. Y.*

AMPHISTROPHIA, HALL.

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AMPHISTROPHIA STRIATA, Hall.

Fig. 12. A dorsal view of conjoined valves.

Fig. 13. The interior of a pedicle-valve; showing the extension of the dental lamellæ along the muscular area and the crenulation of the cardinal margins near the delthyrium.

Fig. 14. An enlargement near the central portion of the brachial valve; showing the lobed cardinal process, the huge crenulations and the small chilidium.

Niagara group. *Waldron, Indiana.*

PLATE 16.

Legend. D. Deltidium.
A. Cardinal area.
I. Umbo-lateral slopes.
t. Teeth.
d. Dental lamellæ.
b. Dental sockets.
j. Cardinal process.
c. Crura.
s. Median septum.
a. Adductor scars.
r. Diductor scars.
fp. Socket walls.

STROPHOMENA, Rafinesque.

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STROPHOMENA PLANUMBONA, Hall, = *Strophomena rugosa*, Rafinesque (de Blainville).

Fig. 1. A dorsal view; showing the usual form and proportions of the species.

Fig. 2. The interior of a brachial valve. On account of the great convexity of this valve, the cardinal process is projected upward at an unusual angle.

Fig. 3. The interior of a pedicle-valve; showing the usual character of the muscular markings.
Hudson River group. *Lebanon, Ohio.*

Fig. 4. An enlargement of the cardinal process and crural plates. × 2.

Fig. 5. The corresponding portion of the opposite valve; showing the irregularly crenulated character of the surface of the teeth. × 2.
Hudson River group. *Oxford, Ohio.*

STROPHOMENA WISCONSINENSIS, Whitfield.

Fig. 6. A profile of conjoined valves; showing the retrorsion of the beak of the pedicle-valve.

Fig. 7. A cardinal view of the same specimen.
Hudson River group. *Wilmington, Illinois.*

ORTHOTHETES, FISCHER DE WALDHEIM.

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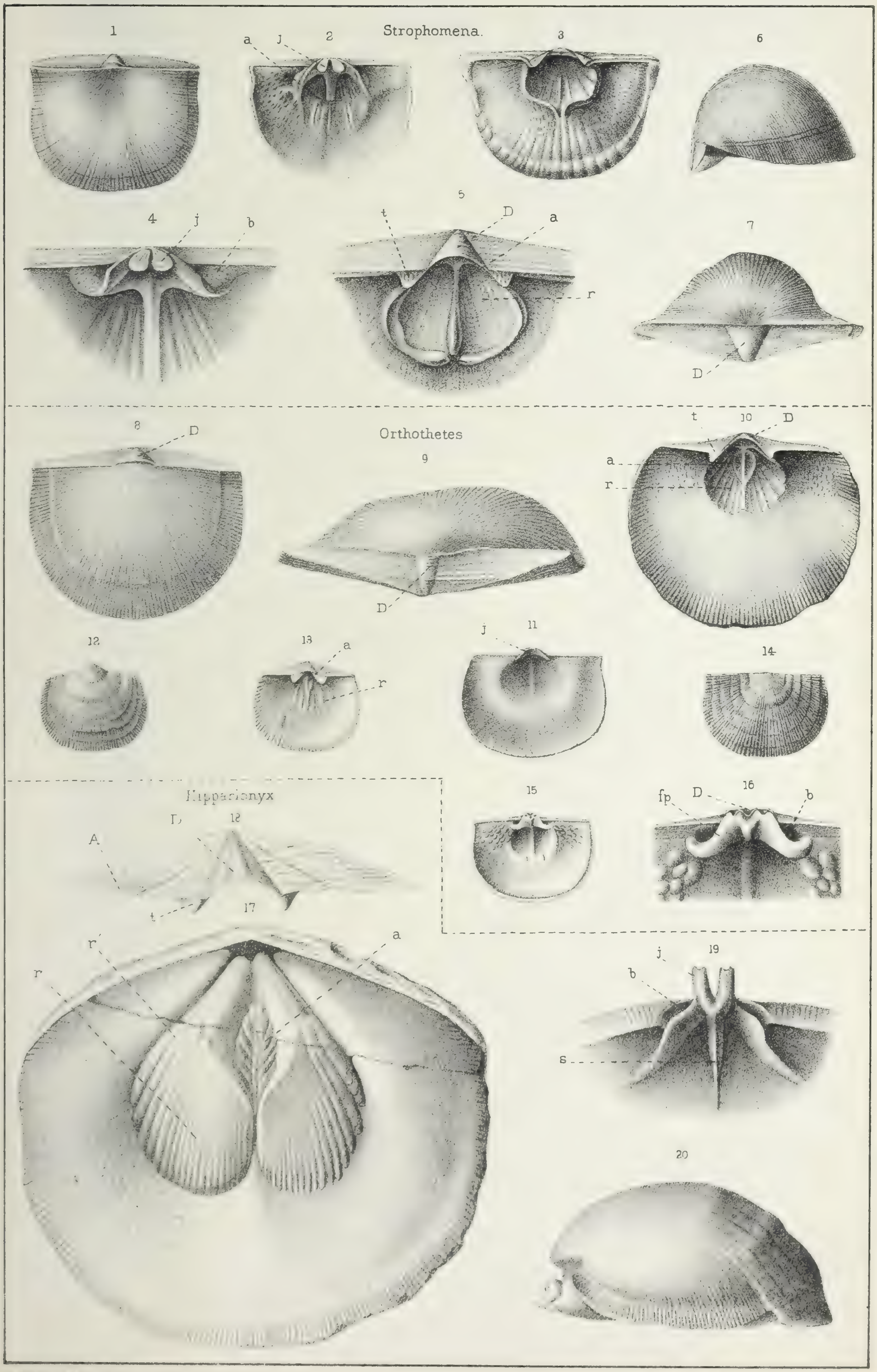
ORTHOTHETES CHEMUNGENSIS, Conrad, var. PANDORA, Billings.

Fig. 8. A dorsal view; showing the cardinal area and deltidium of the pedicle-valve.

Fig. 10. The interior of a pedicle-valve; showing the low deltidium, unsupported teeth, the adductor and diductor scars.
Corniferous limestone. *Caledonia, N. Y.*

BRACHIOPODA.

Generic Illustrations.



ORTHOTHETES CHEMUNGENSIS, Conrad.

Fig. 9. A cardinal view of a specimen; showing the irregular form of the shell, the usual width of the area, and the character of the deltidium.

Chemung group. *Southwestern New York.*

ORTHOTHETES CHEMUNGENSIS, Conrad, var. ALTERNATA, Hall.

Fig. 11. The interior of the brachial valve; showing the characteristic cardinál process.

Hamilton group. *Canandaigua Lake, N. Y.*

ORTHOTHETES LENS, White.

Fig. 12. The exterior of a pedicle-valve.

Fig. 13. The interior of the same valve; showing area, deltidium, teeth and muscular impressions.

Fig. 14. The exterior of a brachial valve.

Fig. 15. The interior of the same valve; showing cardinal process, muscular impressions and ovarian markings.

Fig. 16. The cardinal process of the same specimen, enlarged to show its structure. Its outer face is covered by the chilidium, which conforms to the grooved surface of the lobes. The crural plates are strongly recurved at their bases about the dental sockets. × 3.

Choteau limestone. *Louisiana, Missouri.*

HIPPARIONYX, VANUXEM.

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HIPPARIONYX PROXIMUS, Vanuxem.

Fig. 17. A natural cast of the interior of a pedicle-valve; showing the impressions of the adductor and diductor muscles.

Fig. 18. The exterior of the cardinal area of the pedicle-valve; showing the covered delthyrium and the projecting teeth. From a gutta-percha impression.

Fig. 19. The cardinal process and its adjoining parts, as obtained from a gutta-percha impression of a natural cast of the interior; natural size. This figure shows very clearly the almost complete obsolescence of the cardinal area, the marginal crenulations extending to the dental sockets.

Oriskany sandstone. *Albany county, N. Y.*

Fig. 20. Profile of an internal cast of the two valves. The specimen is drawn with the brachial valve above and shows the relative convexity of the valves and the extent of the crenulated margin toward the apex.

Oriskany sandstone. *Cayuga, Province of Ontario.*

PLATE 17.

Legend. t. Teeth.
d. Dental lamellæ.
b. Dental sockets.
c. Crural plates.
s. Median septum.
j. Cardinal process.
r. Diductor scars.
a. Anterior adductors.
a′. Posterior adductors.

DERBYA, WAAGEN.

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DERBYA CRASSA, Meek and Hayden.

Fig. 1. The exterior of a large pedicle-valve.

Figs. 2, 3. The interior of both valves of the specimen; showing the muscular scars; the median septum and area of the pedicle-valve, and the cardinal process of the brachial valve.

Upper Coal Measures. *Near Kansas City, Missouri.*

Fig. 4. The interior of a large and old pedicle-valve; showing the median septum, the thickening about the muscular area, due to age, and marks of vascular sinuses.

Upper Coal Measures. *Winterset, Iowa.*

Fig. 9. The cardinal process enlarged; showing the lobation at its summit and the extent of the crural plates. × 3.

Upper Coal Measures. *Kansas City, Missouri.*

DERBYA BENNETTI, Hall.

Fig. 5. Cardinal view of conjoined valves; showing the high cardinal area and the lack of symmetry in the pedicle-valve.

Fig. 6. Profile view of the same specimen.

Fig. 7. A similar section of the same specimen near the apex. Here the median septum is coalesced with a solid callosity filling the apical portion of the deltidial cavity.

Fig. 8. The same specimen after having the pedicle-valve cut horizontally near the hinge. The section shows the unsupported dental ridges, the tips of the grooved cardinal process, and the extravagant development of the median septum.

Upper Coal Measures. *Kansas City, Missouri.*

MEEKELLA, WHITE AND ST. JOHN.

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MEEKELLA STRIATOCOSTATA, Cox.

Fig. 10. Cardinal view of a large, symmetrical individual, essentially an internal cast in chert; showing the position of the dental and crural plates.

Upper Coal Measures. *Winterset, Iowa.*

BRACHIOPODA.

Generic Illustrations.

Report State Geologist, 1891. Plate 17.

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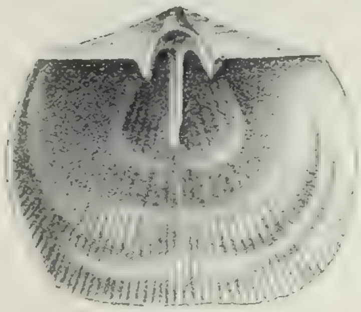

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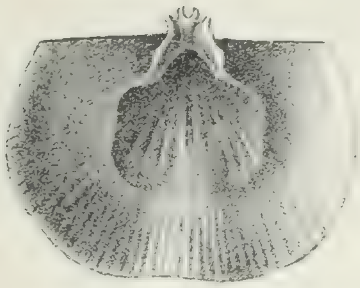

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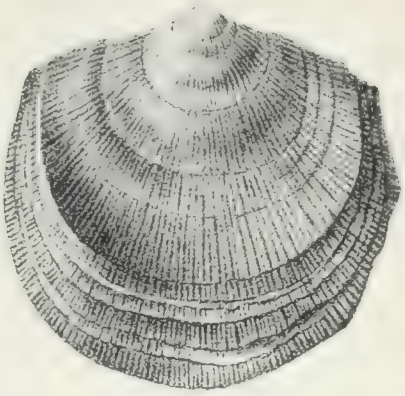

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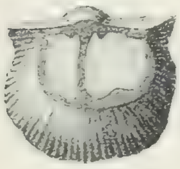

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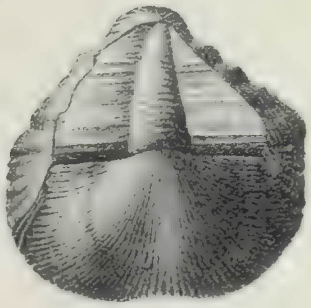

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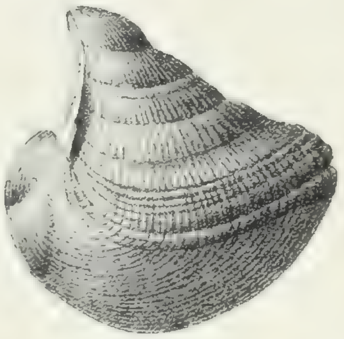

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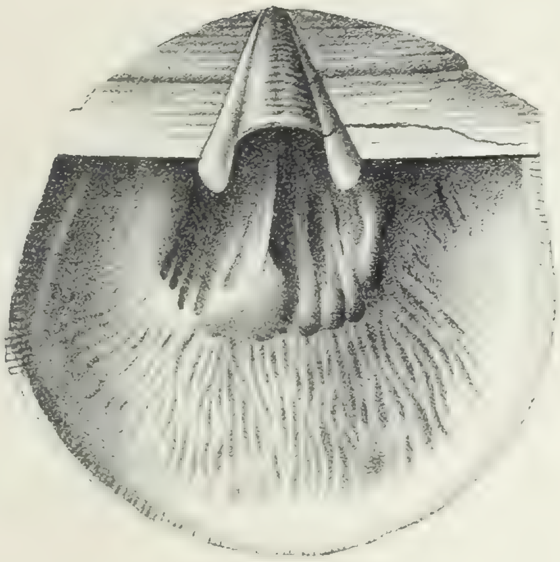

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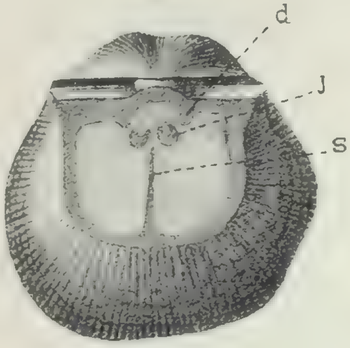

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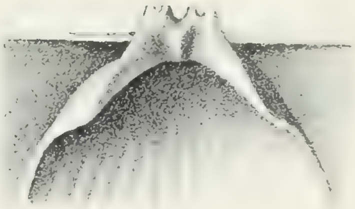

Meekella.

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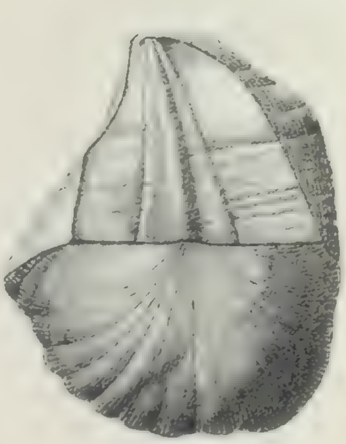

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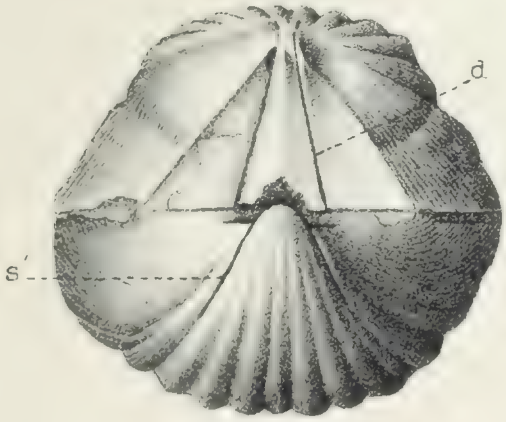

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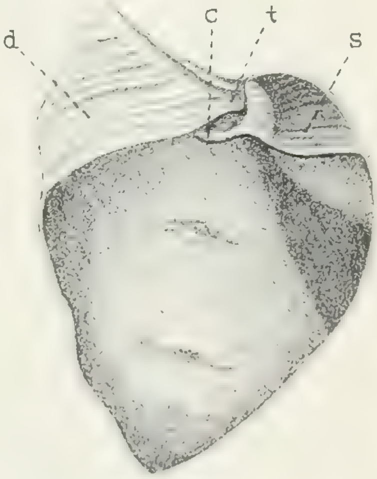

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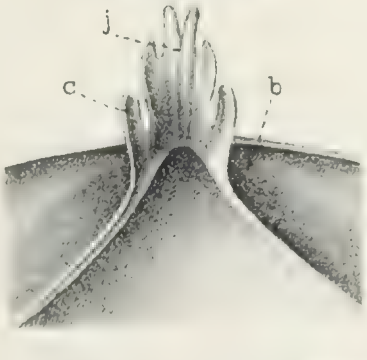

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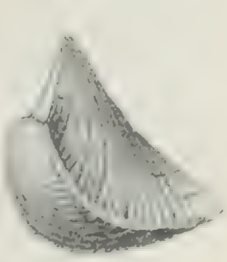

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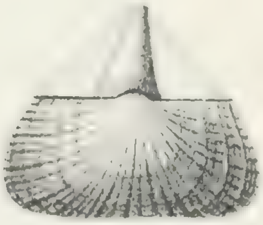

Streptorhynchus

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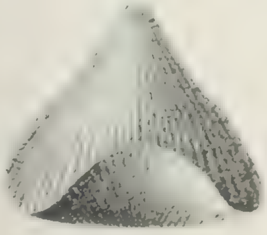

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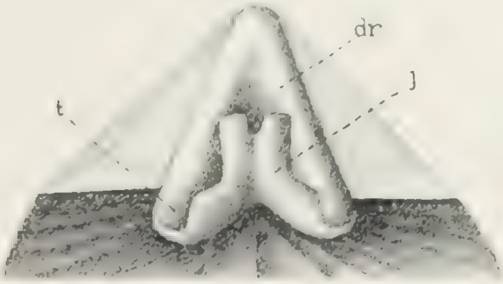

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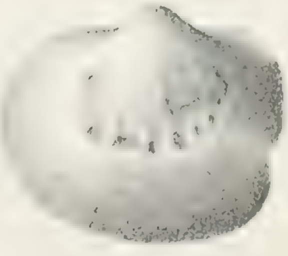

Fig. 11. Cardinal view of a distorted specimen, with an unusually high cardinal area.

Upper Coal Measures. *Lawrence county, Kansas.*

Fig. 12. A longitudinal section of the valves; showing the extent of the dental lamellæ and crural plates.

Fig. 13. An enlargement of the cardinal process; showing the extreme elevation of the lobes and the crural plates.

Upper Coal Measures. *Winterset, Iowa.*

STREPTORHYNCHUS, King.

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Streptorhynchus pelargonatus, Schlotheim.

Figs. 14, 15, 16. Profile, anterior, and cardinal views of a specimen which retains the shell; showing the contour and general external character of the species. × 2.

Fig. 17. An internal cast of the pedicle-valve; showing the form of the muscular area, without evidence of a median septum. × 2.

Fig. 18. The interior of the cardinal portion of the articulated valves; showing the dental ridges and inner surface of the deltidium, the cardinal process, crural plates and the character of the articulation. × 5.

Permian System. *Pösneck, Silesia.*

PLATE 18.

Legend.			
F.	Foramen.	d.	Dental lamellæ.
ps.	Deltidium.	a.	Anterior adductors.
c.	Crura.	a′.	Posterior adductors.
j.	Cardinal process.	r.	Diductors.

TRIPLECIA, Hall.

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Triplecia extans, Emmons.

Fig. 1. A dorsal view of an individual of average dimensions.

Fig. 2. An anterior view of the same.
Trenton limestone. *Lowville, N. Y.*

Fig. 3. The cardinal area of the pedicle-valve; showing the apical foramen and the convex deltidial covering.
Trenton limestone. *Carlton Island, N. Y.*

Fig. 4. A cardinal view of a brachial valve; showing the bifurcated cardinal process extending into the matrix.
Trenton limestone. *Middleville, N. Y.*

Triplecia nucleus, Hall.

Figs. 5, 6. Cardinal and profile views of a normal individual, the former showing the foramen and deltidium of the pedicle-valve. × 2.
Trenton limestone. *Middleville, N. Y.*

Triplecia ortoni, Meek.

Fig. 7. The exterior of a brachial valve.

Fig. 8. Cardinal view of a specimen having the valves in conjunction; showing the cardinal area, foramen and deltidium.

Fig. 9. The external cardinal area of conjoined valves. × 3.

Fig. 10. The central cardinal portion of an old and thickened brachial valve. The tips of the cardinal process and of one of the crura have been broken.

Fig. 11. Interior of the cardinal region of conjoined valves; showing their mode of articulation.

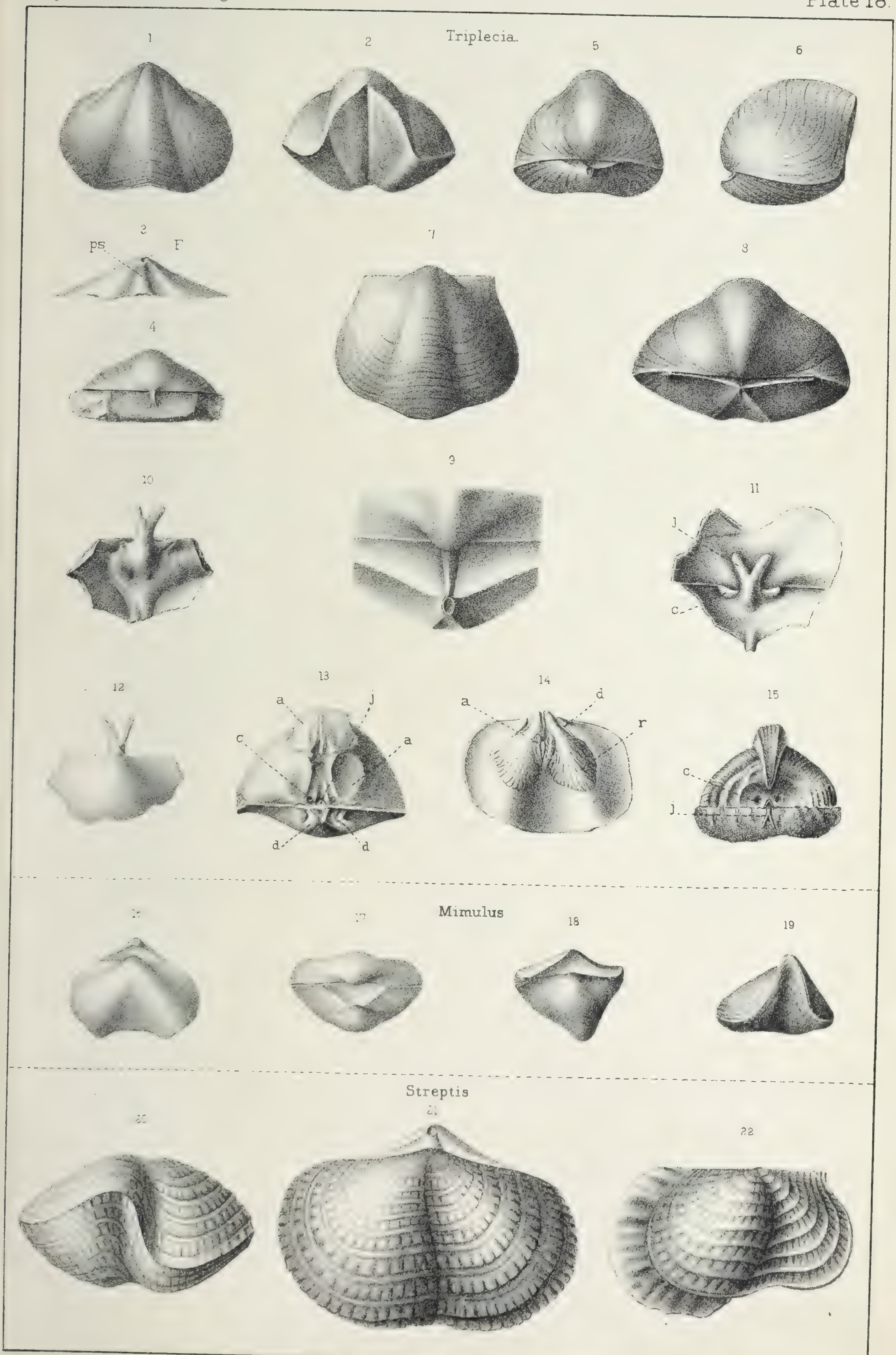
Fig. 12. Posterior view of the cardinal process; showing the grooves on the outer face of its branches.
Clinton group. *Dayton, Ohio.*

BRACHIOPODA.

Generic Illustrations.

Report State Geologist, 1891

Plate 18.



TRIPLECIA INSULARIS, Eichwald.

Fig. 13. Cardinal view of an internal cast of the conjoined valves; showing, in the brachial valve, the impressions of the anterior and posterior adductors, the crura and cardinal process, and, in the pedicle-valve, the extent of the dental lamellæ.

Caradoc sandstone. *Ty-Isaf, Wales.*

TRIPLECIA WENLOCKENSIS, Davidson.

Fig. 14. A cast of the interior of the pedicle-valve; showing the adductor and diductor muscular scars and the impressions of the dental lamellæ.

Wenlock limestone. *England.*

TRIPLECIA SPIRIFEROIDES, McCoy.

Fig. 15. A cardinal view of an internal cast of a brachial valve; showing the impressions of the crura and the bifurcated cardinal process.

Caradoc sandstone. *North Wales.*

MIMULUS, BARRANDE.

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MIMULUS PERVERSUS, Barrande.

Fig. 16. Dorsal view of the shell; showing the sinus on the brachial valve and the uninterrupted cardinal area of the pedicle-valve.

Fig. 17. Cardinal view of the same specimen.

Etagé E_2. *Listice, Bohemia.*

MIMULUS WALDRONENSIS, Miller and Dyer.

Fig. 18. Cardinal view of an adult individual, the type specimen. The cardinal area shows no trace of deltidium or foramen. × 3.

Fig. 19. Anterior view of the same specimen; showing the peculiar asymmetry of the shell.

Niagara group. *Waldron, Indiana.*

STREPTIS, DAVIDSON.

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STREPTIS GRAYI, Davidson.

Figs. 20, 21. Anterior and dorsal views; showing the asymmetry of the valves, the concentric ornamentation and the perforated deltidium. × 5. (DAVIDSON.)

Wenlock limestone. *Dudley, England.*

Fig. 22. A brachial valve which retains the lamellar expansion at one of the growth-lines. × 4.

Etagé E_2. *Lodenitz, Bohemia.*

PLATE 19.

Legend. D. Deltidium.
C. Chilidium.
t. Teeth.
d. Dental lamellæ.
j. Cardinal process.
c. Crura.
br. Brachial ridges.
a. Anterior adductor scars.
a′. Posterior adductor scars.
r. Diductor scars.
x. Scar of attachment.

PLECTAMBONITES, Pander.

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Plectambonites transversalis, Dalman.

Fig. 1. The exterior of a pedicle-valve. × 2.
Niagara group. *Lockport, N. Y.*

Fig. 2. An internal cast of the pedicle-valve; showing the muscular and vascular impressions. × 2.
Niagara dolomites. *Near Milwaukee, Wisconsin.*

Fig. 3. The interior of a brachial valve; showing the elongate adductor scars. × 2.
Niagara group. *Lockport, N. Y.*

Plectambonites sericea, Sowerby.

Fig. 4. A dorsal view of conjoined valves; showing the area and closed delthyrium of the pedicle-valve.

Fig. 5. The interior of the brachial valve; showing the depressed visceral disk, the muscular scars and the cardinal process.

Fig. 6. The interior of the pedicle-valve; showing the divergent muscular scars.

Fig. 7. An enlargement of the cardinal process; showing its union with the crural plates and the abrupt termination of the latter. The process is simple, but on its posterior face appears trilobed from coalescence with the ends of the crural plates. × 3.
Trenton horizon. *Mineral Point, Wisconsin.*
Also Trenton limestone and Hudson River group, New York.

CHRISTIANIA, Hall.

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Christiania subquadrata, Hall.

Figs. 8, 9. Two views of the pedicle-valve; showing its elongate form, incurvature, and smooth or squamous exterior. × 2.

Fig. 10. Cardinal view of the brachial valve; showing the bilobed cardinal process, widely divergent crural plates, the prominent longitudinal and transverse muscular ridges inclosing the impression of the adductor muscles. × 3.

BRACHIOPODA.

Generic Illustrations.

Plectambonites.

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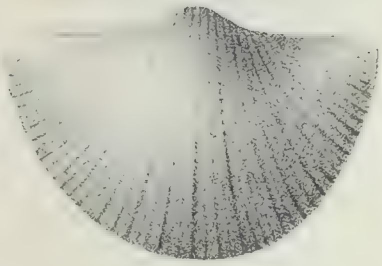

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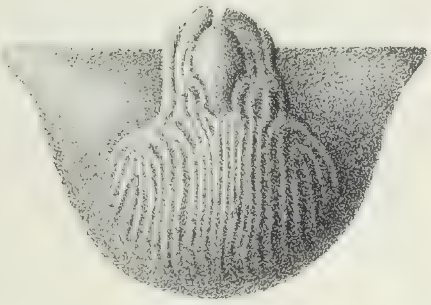

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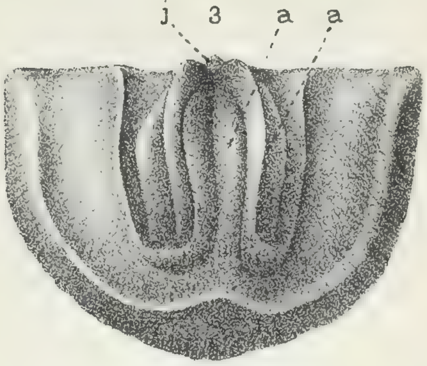

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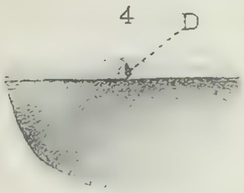

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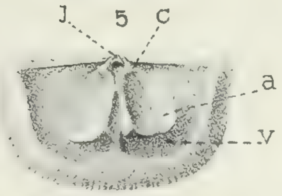

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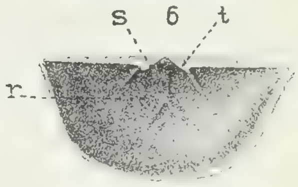

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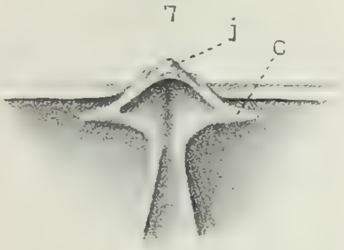

Christiania.

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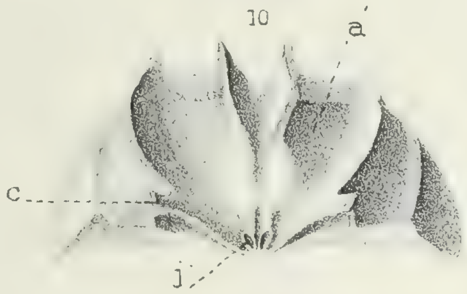

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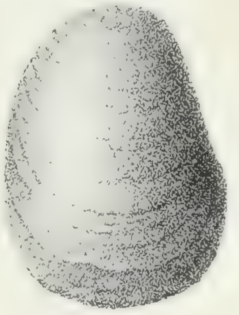

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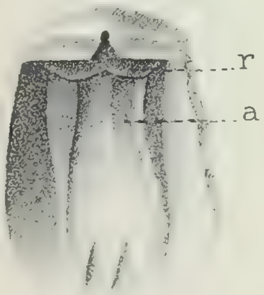

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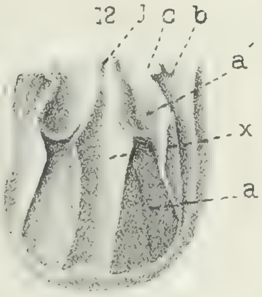

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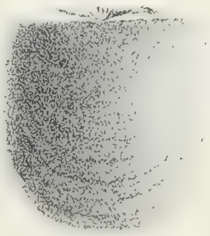

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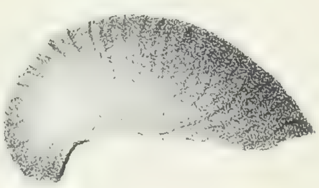

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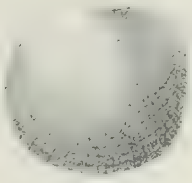

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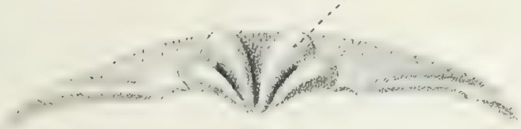

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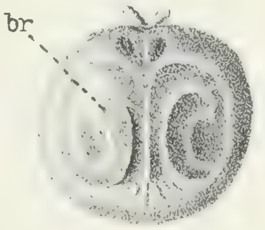

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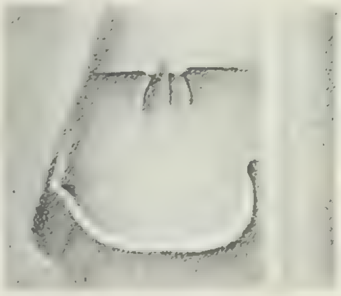

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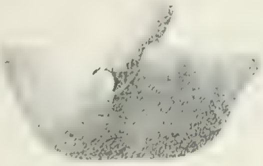

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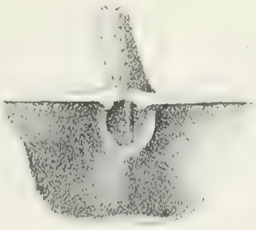

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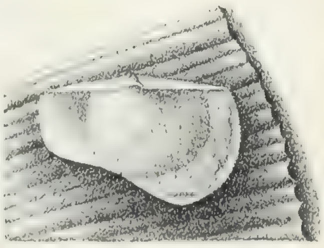

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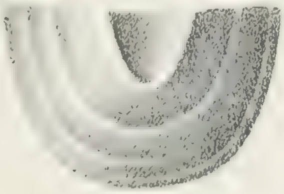

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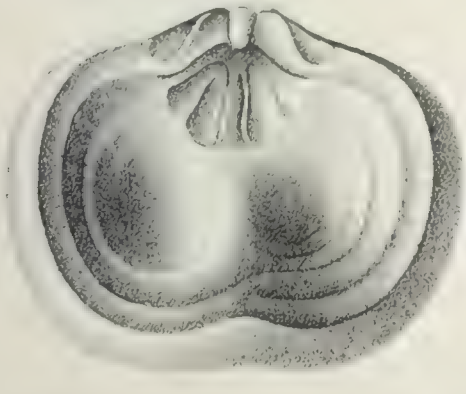

Davidsonia.

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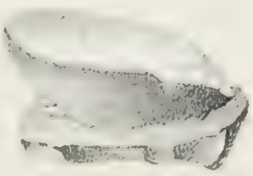

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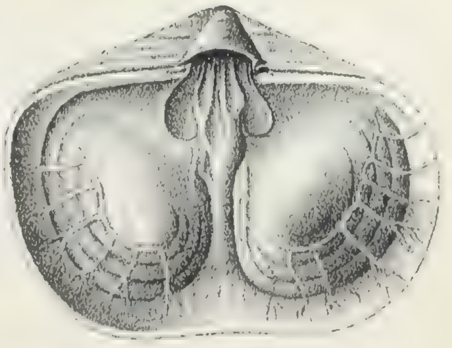

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Fig. 11. The interior of the pedicle-valve; showing the open delthyrium, muscular walls and scars.

Fig. 12. The interior of a brachial valve; showing the bilobed cardinal process and the quadruple adductor scar, divided by high, vertical muscular walls.

Fig. 13. The exterior of the brachial valve; showing the cardinal process and edges of the crural plates.

Lower Helderberg group. *Perry county, Tennessee.*

LEPTÆNISCA, BEECHER.

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LEPTÆNISCA CONCAVA, Hall.

Fig. 14, The exterior of a pedicle-valve; showing the scar at the beak, due to the attachment of the shell.

Fig. 15. Cardinal view of an imperfect brachial valve preserving the character of the cardinal process, which is deeply quadrilobate. × 3.

Fig. 16. The interior of a brachial valve, somewhat imperfect about the margins and cardinal process, but showing the spiral brachial ridges and the thin median septum. × 2.

Lower Helderberg group. *Near Clarksville, N. Y.*

LEPTÆNISCA ADNASCENS, Hall.

Fig. 17. A pedicle-valve attached by nearly its entire outer surface to the interior of a valve of *Orthis oblata*. The specimen shows the dental lamellæ and median ridge dividing the muscular area. × 3.

Fig. 20. A specimen retaining both valves, attached to *Orthis perelegans*. × 4.

Lower Helderberg group. *Near Clarksville, N. Y.*

LEPTÆNISCA TANGENS, Hall.

Figs. 18, 19. Opposite sides of a pedicle-valve attached to a twig of TREMATOPORA. × 3.

Fig. 21. The exterior of a pedicle-valve in which the rugose growth has obscured the median sinus. The deep umbonal scar is due to attachment to some bryozoan. × 3.

Lower Helderberg group. *Near Clarksville, N. Y.*

DAVIDSONIA, BOUCHARD.

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DAVIDSONIA VERNEUILIANA, Bouchard.

Figs. 22, 24. Interiors of the brachial and pedicle-valves respectively.

Fig. 23. Profile of an attached specimen retaining the two valves. (DAVIDSON.)

PLATE 20.

Legend.			
D.	Deltidium.	j.	Cardinal process.
C.	Chilidium.	a.	Anterior adductors.
st.	Cardinal tubes.	a′.	Posterior adductors.
t.	Teeth.	r.	Anterior diductors.
b.	Dental sockets.	r′.	Posterior diductors.
s.	Septum.	v.	Brachial ridges.

CHONETES, Fischer de Waldheim.

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Chonetes cornuta, Hall.

Fig. 1. A view of the pedicle-valve. × 2.
Clinton group. *Sodus Bay, N. Y.*

Chonetes setigera, Hall.

Fig. 2. Pedicle-valve of a larger specimen with finer striæ. × 2.
Marcellus shales. *Near Caledonia, N. Y.*

Chonetes mucronata, Hall.

Fig. 3. A pedicle-valve with long, extremely divergent spines. × 2.
Marcellus shales. *West Avon, N. Y.*

Chonetes Acutiradiata, Hall.

Fig. 4. The pedicle-valve.
Corniferous limestone. *Williamsville, N. Y.*

Chonetes Verneuiliana, Norwood and Pratten.

Figs. 5, 6. Two views; showing the strong median constriction. × 2.
Coal Measures. *Illinois.*

Chonetes mesoloba, Norwood and Pratten.

Fig. 7. A pedicle-valve; showing the median fold. × 2.
Coal Measures. *Illinois.*

Chonetes coronata, Conrad.

Fig. 8. A view of the brachial valve; showing the cardinal area and deltidium.

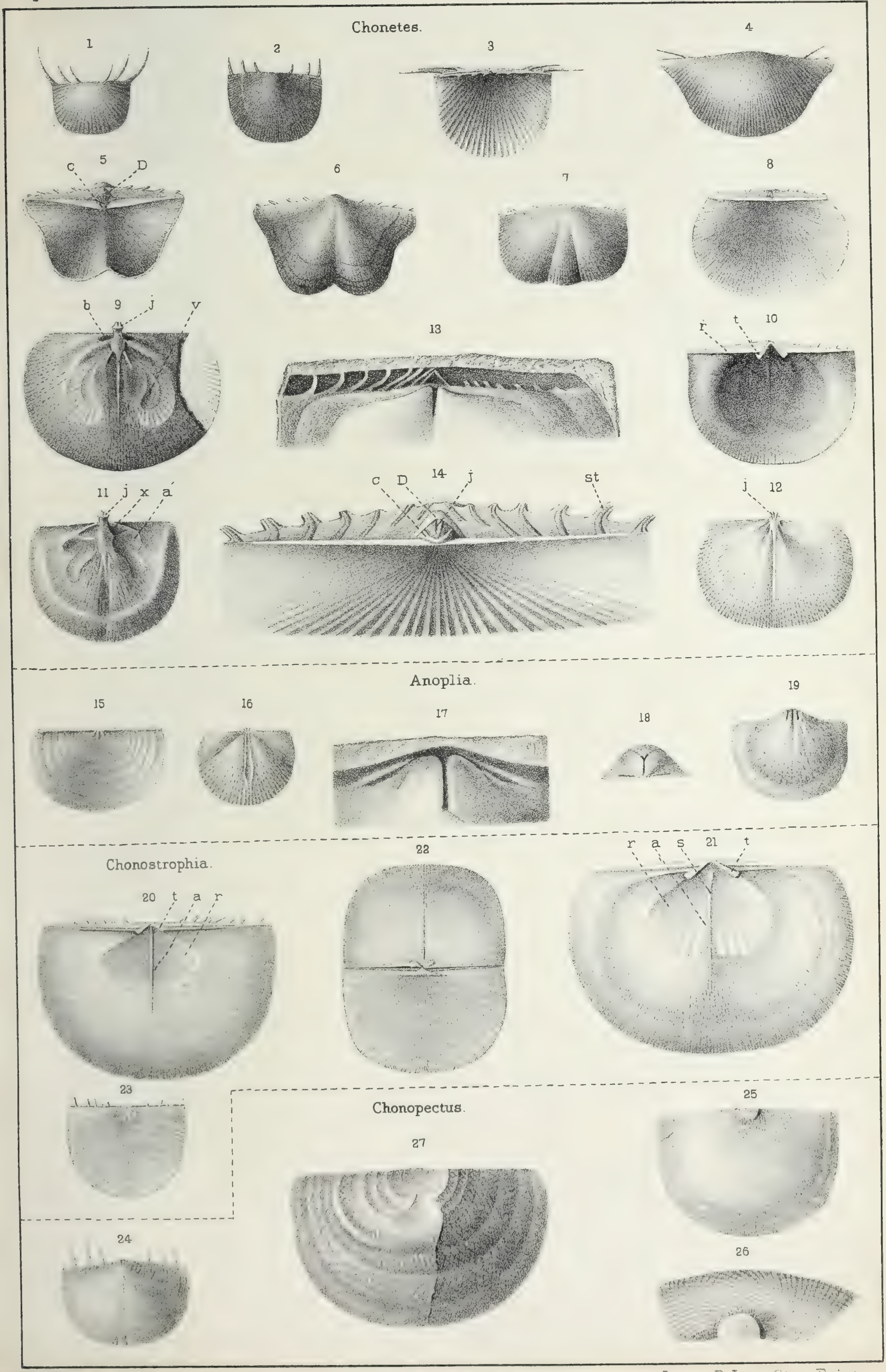
Fig. 9. The interior of a brachial valve; showing the cardinal process, muscular scars and brachial ridges.
Hamilton group. *York, N. Y.*

Fig. 12. The interior of another brachial valve; showing more distinctly the lobation of the cardinal process.
Hamilton group. *Western New York.*

BRACHIOPODA.

Generic Illustrations.

Report State Geologist, 1891. Plate 20.



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CHONETES LINEATA, Conrad.

Fig. 10. The interior of a pedicle-valve; showing the area, teeth and muscular impressions. × 2.

Corniferous limestone. *Western New York.*

CHONETES DEFLECTA, Hall.

Fig. 11. The interior of a brachial valve. × 2.

Hamilton group. *Western New York.*

CHONETES AMAZONICA, Derby.

Fig, 13. An enlargement of an internal cast of the pedicle-valve, which retains the filling of the spine-tubes crossing the cavity left by the removal of the cardinal portion of the valve. × 3.

Coal Measures. *Rio Tapajos, Brazil.*

CHONETES SCITULA, Hall.

Fig. 14. An enlargement of the cardinal portion of the valves; showing the hollow spines and the curving course of the spine-tubes through the substance of the cardinal area of the pedicle-valve. × 8.

Hamilton group. *Western New York.*

ANOPLIA, HALL.

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ANOPLIA NUCLEATA, Hall.

Fig. 15. The exterior of the brachial valve; showing the smooth surface. × 3.

Oriskany sandstone. *Jones county, Illinois.*

Fig. 16. The interior of the brachial valve; showing its similarity to that of CHONETES. × 2.

Fig. 17. The central cardinal portion of an internal cast of the pedicle-valve; showing the filling of the oblique cardinal tubes which do not penetrate to the external surface. × 6.

Oriskany sandstone. *Columbia county, N. Y.*

Fig. 18. Cardinal view of an internal cast of the pedicle-valve, retaining the impressions of the extremely oblique dental lamellæ, and the short median septum. × 3.

Oriskany sandstone. *Albany county, N. Y.*

Fig. 19. Internal cast of a pedicle-valve; showing the impression of the short median septum, and the pustulose character of the pallial region. × 3.

Oriskany sandstone. *Columbia county, N. Y.*

CHONOSTROPHIA, HALL.

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CHONOSTROPHIA COMPLANATA, Hall.

Fig 20. The interior of a pedicle-valve; showing the reversed convexity of the shell, the flabellate muscular area, conspicuous median septum and cardinal spines.

Fig. 21. Another exterior of a similar valve in which the spines are apparently wanting.

Oriskany sandstone. *Albany county, N. Y.*

CHONOSTROPHIA HELDERBERGIA, Hall.

Fig. 22. A specimen in which the valves are opened, exposing their internal surfaces. The shell may have been somewhat flattened in fossilization, but still shows the reversal of the relative convexity of the valves, the cardinal area, teeth and faint median septum of the pedicle-valve, and the finely lineate surface. The cardinal process is not retained with sufficient distinctness to permit its accurate delineation.

Lower Helderberg group. *Near Clarksville, N. Y.*

CHONOSTROPHIA REVERSA, Whitfield.

Fig. 23. The exterior of a pedicle-valve which retains the cardinal spines. × 2.

Upper Helderberg group. *Cayuga, Ontario.*

CHONOPECTUS, HALL.

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CHONOPECTUS FISCHERI, Norwood and Pratten.

Fig. 24. A small pedicle-valve, retaining the cardinal spines, and showing, over the body of the shell, some divergent impressions which may be of vascular origin.

Fig. 25. A pedicle-valve having the normal proportions of the species, and showing a few spine bases on the cardinal margin. The reticulate surface markings, as on this specimen, do not usually extend over the pallial region, which is covered by exceedingly fine, often irregular, radiating striæ.

Fig. 26. Posterior view of the umbonal region in the same specimen, enlarged to show character of the cicatrix. × 2.

Yellow sandstones. *Burlington, Iowa.*

Fig. 27. The exterior of a pedicle-valve which retains the reticulate surface ornamentation and a large scar of attachment. × 2.

In strata referred to the age of the Waverly group. *Warren, Pennsylvania.*

PLATE 21.

Legend.
A. Cardinal area.
D. Deltidium.
C. Chilidium.
t. Teeth.
b. Dental sockets.
j. Cardinal process.
v. Brachial ridges.
a. Anterior adductors.
a′. Posterior adductors.
r. Diductors.

STROPHALOSIA, King.

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Strophalosia trunctata, Hall.

Fig. 1. The interior of a brachial valve; showing the cardinal process.

Fig. 2. The exterior of a brachial valve; showing the convex umbo, corresponding to the truncation of the apex of the opposite valve. × 2.

Figs. 3, 4. Two views of a pedicle-valve; showing the truncation of the beak. × 2.

Marcellus shales. *Western New York.*

Strophalosia muricata, Hall.

Fig. 5. Two views of a pedicle-valve; showing the cicatrix of attachment.

Fig. 6. An internal cast of the pedicle-valve; showing the muscular impressions.

Chemung group *Meadville, Pennsylvania.*

Strophalosia radicans, Winchell.

Fig. 7. The calyx of a single polypite of *Acervularia Davidsoni*, to which is attached a pedicle-valve of this species, its adherent spines running between the septa of the coral. × 3.

Fig. 8. A pedicle-valve situated in a cavity among the polypites of *Acervularia Davidsoni.* There is a slight attachment by the apex of the valve but fixation is mainly effected by the spines. Those on the cardinal margin creeping along the surface of a polypite, and several of those which are on the body of the valve crossing the cavity, their extremities being somewhat obscured by the matrix of the specimen. These spines appear to increase slightly in diameter from the surface of the shell outward and their surface is marked with fine concentric annulations. × 3.

Fig. 9. A pedicle-valve attached by its entire outer surface and spines to a Fistulipora. × 2.

Hamilton group. *Little Traverse Bay, Michigan.*

STROPHALOSIA CORNELLIANA, Derby.

Fig. 10. The interior cardinal portion of the pedicle-valve; showing the area, deltidium; teeth and muscular scars. × 3.
Coal Measures. *Bomjardim, Brazil.*

STROPHALOSIA GERARDI, King.

Fig. 11. View of the shell; showing the lamellose brachial valve, cardinal areas, deltidia and the umbonal cicatrix. (DAVIDSON.)
Permian. (?) *Spiti, India.*

AULOSTEGES, VON HELMERSEN.

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AULOSTEGES WANGENHEIMI, de Verneuil.

Fig. 12. The interior of a brachial valve. (DAVIDSON.)

Fig. 13. The cardinal area of the pedicle-valve; showing the spiniform tubercles on the surface of the deltidum. × 2.

Fig. 14. Dorsal view of conjoined valves; showing the character of the exterior. (DAVIDSON.)
Permian. *Orenburg, Russia.*

PRODUCTELLA, HALL.

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PRODUCTELLA COSTATULA, Hall.

Figs. 15, 16, 17. Three views of a pedicle-valve.
Chemung group. *Chemung county, N. Y.*

PRODUCTELLA ONUSTA, Hall.

Fig. 18. The interior of a brachial valve; showing cardinal process, dental sockets, muscular and brachial impressions.
Chemung group. *Cattaraugus county, N. Y.*

Fig. 19. Cardinal view of an internal cast of the pedicle-valve; showing the muscular scars.
Chemung group. *Conewango, N. Y.*

PRODUCTELLA PYXIDATA, Hall.

Fig. 20. The cardinal portion of the pedicle-valve; showing the area and teeth. × 2.

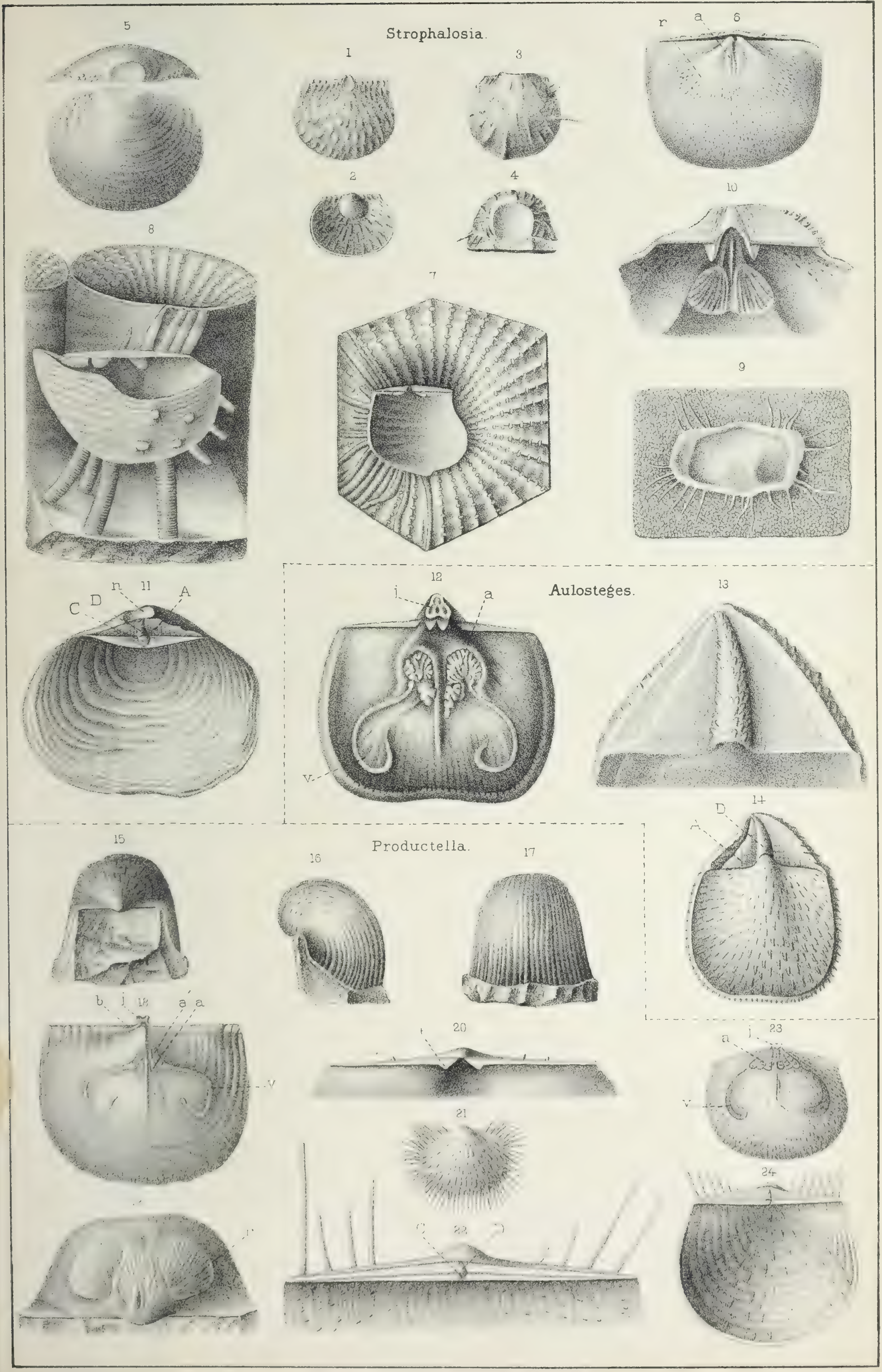
Fig. 23. The interior of a brachial valve; showing the cardinal process, muscular scars and brachial ridges.
Choteau limestone. *Pike county, Missouri.*

BRACHIOPODA.

Generic Illustrations.

Report State Geologist, 1891.

Plate 21.



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PRODUCTELLA HYSTRICULA, Hall.

Fig. 21. The exterior of the pedicle-valve; showing the fine, closely crowded spines.
Chemung group. *Chautauqua county, N. Y.*

PRODUCTELLA, sp. (?)

Fig. 22. Cardinal view of an undetermined species, which retains the cardinal areas and deltidia of both valves and the marginal spines of the pedicle-valve. × 2.
Chemung group. *Greenwood, N. Y.*

PRODUCTELLA PRODUCTOIDES, Murchison.

Fig. 24. View from the brachial valve; showing the cardinal area and deltidia, and the marginal spines of the pedicle-valve. (DAVIDSON.)
Upper Devonian. *North Devon, England.*

1891. 45 221

PLATE 22.

Legend. j. Cardinal process.	a. Anterior adductors.
s. Septum.	a′. Posterior adductors.
v. Brachial ridges.	r. Diductors.

PRODUCTUS, SOWERBY.

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PRODUCTUS COSTATUS, Sowerby.

Fig. 1. The exterior of a pedicle-valve; showing the general character of the specimens referred to this species in this country.

Coal Measures. *Winterset, Iowa.*

PRODUCTUS SEMIRETICULATUS, Martin.

Fig. 2. Cardinal view of an internal cast of the pedicle-valve; showing the impression of the cardinal area, the posterior and anterior adductor and the diductor muscles.

Coal Measures. *Newcastle, Ohio.*

Fig. 3. Posterior view of the cardinal process; showing the complete coalescence of the inner divisions of the two lateral lobes. × 3.

Fig. 5. The central portion of a brachial valve, which retains with unusual distinctness the muscular and brachial impressions.

Coal Measures. *Bomjardim, Brazil.*

PRODUCTUS SYMMETRICUS, McChesney.

Fig. 4. A portion of the brachial valve enlarged to show the structure of the brachial ridges or areas. The surface within the curved ridges is covered with irregular clusters of fine granules, which become more widely scattered in the central region about the median septum. The origin of this structure, as well as that seen in figures 16 and 18, has not been ascertained. × 2.

Upper Coal Measures. *Near Kansas City, Missouri.*

PRODUCUTUS (? AURICULATUS, Swallow).

Fig. 6. The exterior of a pedicle-valve, the surface of which is free of spines except along the cardinal margin.

Coal Measures. *Near Kansas City, Missouri.*

PRODUCTUS NEBRASCENSIS, Owen (= *P. aspersus*, McChesney).

Fig. 7. The exterior of a specimen; showing the great abundance of short spines.

Coal Measures. *La Salle, Illinois.*

Productus

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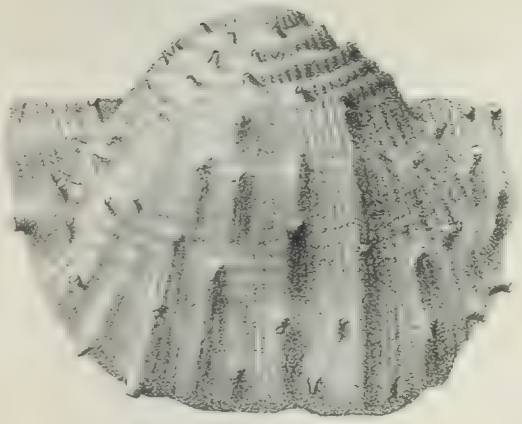

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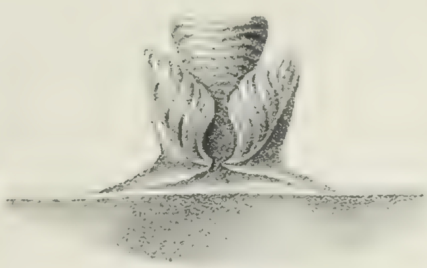

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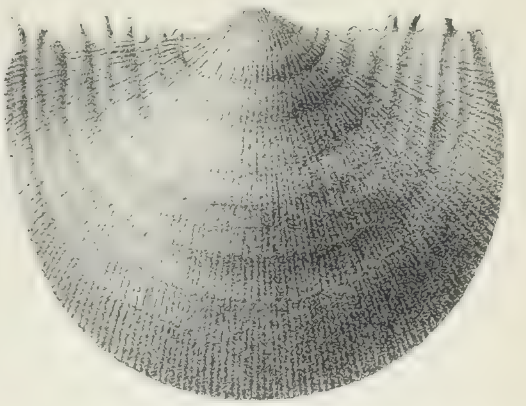

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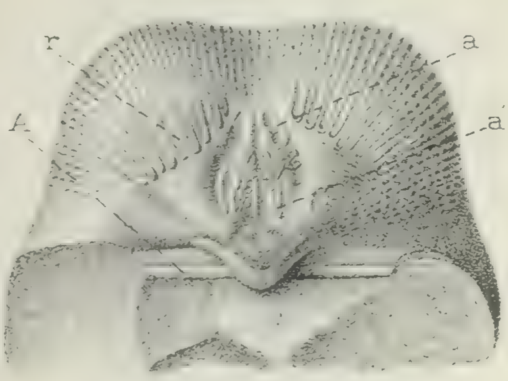

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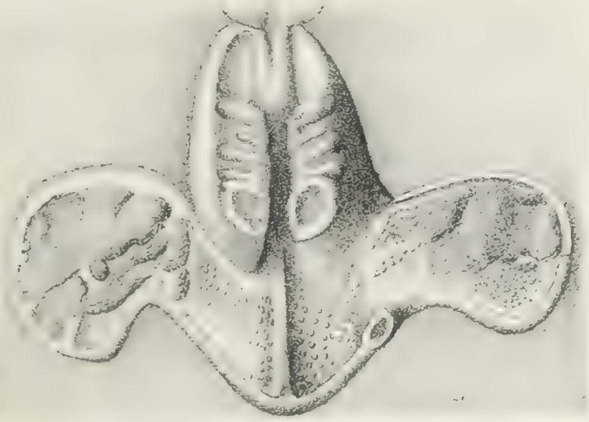

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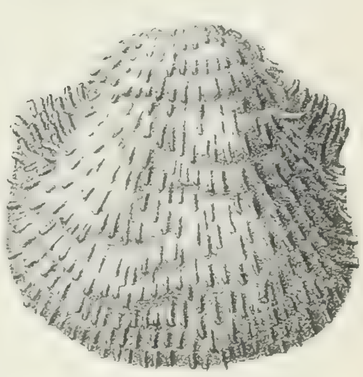

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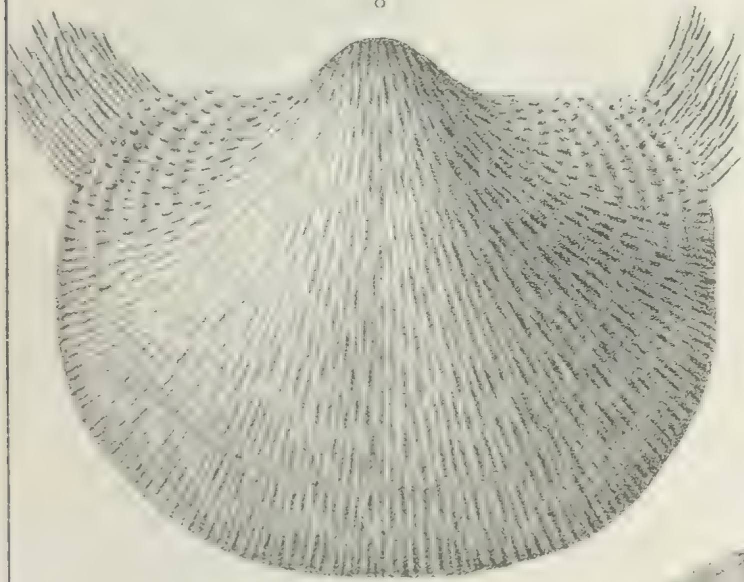

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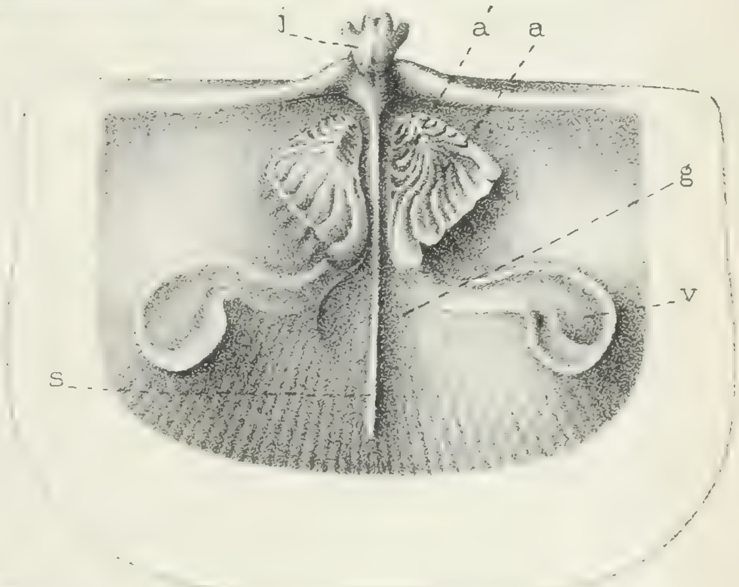

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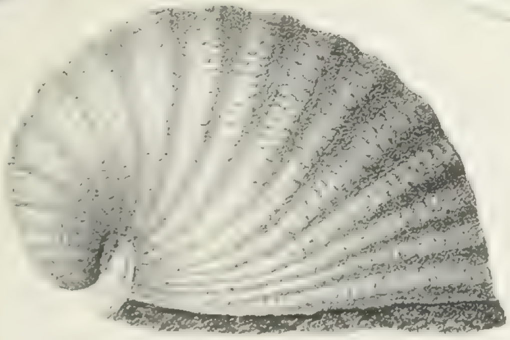

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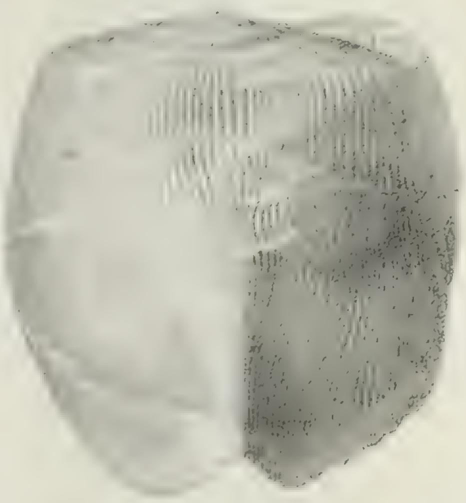

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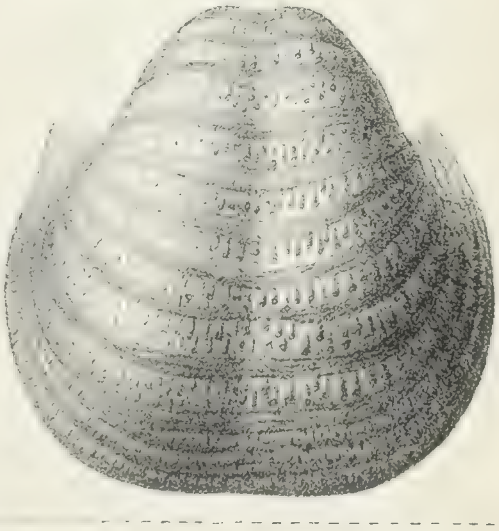

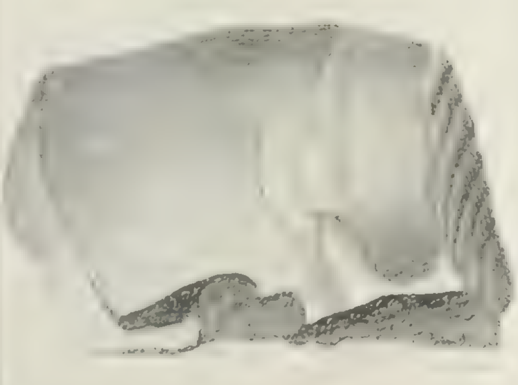

Marginifera.

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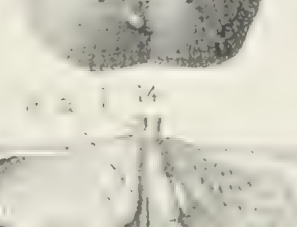

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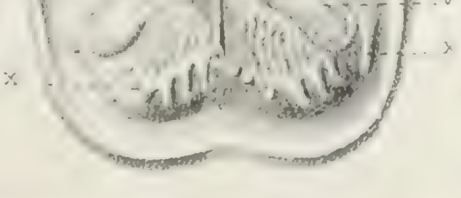

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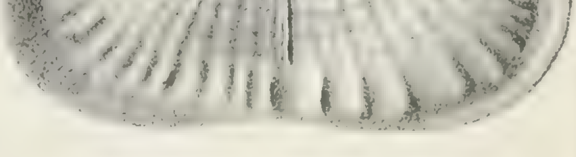

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PRODUCTUS NEWBERRYI, Hall.

Fig. 8. The exterior of a pedicle-valve; showing the numerous spine-bases and retaining the spines at the cardinal extremities.
Waverly sandstone. *Medina, Ohio.*

PRODUCTUS PUNCTATUS, Martin.

Figs. 9, 10. Two views of a pedicle-valve; showing the spiniferous bands which form concentric annulations.
Coal Measures. *Mississippi Valley.*

PRODUCTUS ÆQUICOSTATUS, Shumard.

Figs. 11, 12. The exterior of a specimen from which the upper or visceral portion of the pedicle-valve has been broken; showing the flattened surface of the lower valve and the peculiar mode of growth on the anterior margin, a tendency to infolding which attains its extreme manifestation in the completed tube of PROBOSCIDELLA.
Coal Measures. *Nebraska.*

MARGINIFERA, WAAGEN.

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PRODUCTUS (MARGINIFERA) SPLENDENS, Norwood and Pratten (*P. longispinus*, Sowerby).

Fig. 13. View of a specimen; showing numerous ribs with a few scattered spine-bases, and a nacreous shell texture.
Upper Coal Measures. *Winterset, Iowa.*

Fig. 14. The interior of a brachial valve; showing the cardinal process, muscular impressions and brachial ridges. At *xx* is a row of short spinules which project from the inner surface of the shell, a feature more highly developed here than in any other species observed. The submarginal ridges which characterize WAAGEN'S subgenus MARGINIFERA are not highly developed in this specimen. × 2.
Coal Measures. *La Salle, Illinois.*

PRODUCTUS (MARGINIFERA) LASALLENSIS, Worthen.

Fig. 15. The interior of a brachial valve; showing the character of the internal ridge (*z*), distinguishing the subgenus MARGINIFERA. In this species probably occurs the most extreme development of this feature among the American productids. × 2.
Upper Carboniferous. *La Salle, Illinois.*

STATE OF NEW YORK.

No. 66.

IN SENATE,

JANUARY, 1892.

ANNUAL REPORT

OF THE

STATE BOTANIST.

OFFICE OF THE STATE BOTANIST,
ALBANY, *January*, 1892.

To the Honorable the Regents of the University of the State of New York:

I have the honor to present to you my annual report for the year 1891.

Very respectfully.
CHARLES H. PECK.

STATE OF NEW YORK.

No. 67.

IN SENATE,

January, 1892.

EIGHTH REPORT

OF THE

STATE ENTOMOLOGIST ON THE INJURIOUS AND OTHER INSECTS OF THE STATE OF NEW YORK.

Office of the State Entomologist,
Albany, *January*, 1892.

To the Legislature of the State of New York:

I have the honor to present to the Legislature my Eighth Report on the Insects of the State of New York, which is also presented to the Regents of the University, as required by law.

Very respectfully.

J. A. LINTNER.

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